JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE

State of Pennsylvania,

AND

AMERICAN REPERTORY.

NOVEMBER, 1846.

CIVIL ENGINEERING.

Report of the President and Directors of the Harrisburg, Portsmouth, Mountjoy and Lancaster Rail Road Company to the Stockholders, September 4th, 1846.

The Directors of the Harrisburg, Portsmouth, Mountjoy and Lancaster rail-road Company, in compliance with the Charter, respectfully submit to the Stockholders the Annual Statement of the affairs and business of the Company for the fiscal year ending September 1st, 1846.

Since the last Annual Report of the Directors, the proceeds of the sale of Stock, authorized by act of Assembly, and sanctioned by the Stockholders, has been applied to the purchase of T rail to relay the road, and to the payment of a large portion of the floating debts of the Company (principally under judgment) that have been due and remained unpaid for a considerable length of time; and also to the payment of the deficiency of interest not provided for in the assignment, amounting to over five thousand dollars.

The decayed and defective condition of the flat bar road between Elizabethtown and Harrisburg, compelled the Directors, late in the season, to contract at once for the iron, and commence the work as early and as speedily as possible. Arrangements were made with the Montour Iron Company to furnish the first three hundred tons of T

rail made at their works. Owing to circumstances not within the control of the Directors, the first iron was not delivered until the middle of November, and then, only a part was received in time to be laid down before the frost set in. By extraordinary efforts, the Directors were enabled to relay, with a good and substantial T rail, nearly three miles of the worst part of the road, extending from the Conewago bridge over the roughest and most dangerous part. The remaining fifteen miles of the flat bar road was repaired, and put in as good and safe order before the winter commenced, as the decayed state of the timber would admit.

During the winter, arrangements were made and contracts entered into, to furnish timber for the construction and relaying the whole fifteen miles between Elizabethtown and Harrisburg with a strong T rail; but subsequently, owing to the high price of rail-road iron, and the great difficulty of procuring it, and the impossibility of obtaining sufficient funds to complete the work and raise the assignment, without too great a sacrifice to the Company's interest, the Directors were induced, by a regard to economy and durability, to renew the superstructure on the balance of the road. Sensible that nothing but waste of money, labor and materials, would attend the repairing of the fifteen miles of old track, they determined to relay it with whole flat bars, using in part the perfect bars taken from the old track, the balance being made up by the purchase of new iron.

The manner of constructing the road is as follows: first, longitudinal string pieces of timber, 8 by 10 inches, and from 20 to 60 feet long, are laid on the bed of the road, spliced and pinned together with locust pins; secondly, at intervals of 9 feet, cross-ties of white oak, 3 by 8 inches, and 6 feet long, are mortised in and spiked fast; thirdly, on the string pieces a ribbon or plank of white oak, 3 by 4 inches, and from 15 to 24 feet long, is well fastened and secured; fourthly, on this plank or ribbon the flat bar is laid, and firmly spiked down; all the joints, both under and above the ribbon, are well saturated with gas tar. This plan, after careful consideration, has been adopted as the most judicious both in regard to economy as well as durability. It will be observed, that the height of the ribbon and flat bar is 3½ inches, or just the height of the new T rail. By this mode of construction the flat bar and ribbon can at any time be taken off, and replaced with the T rail at very little trouble or expense.

The eighteen miles of track, from Dillerville to Elizabethtown, laid with T rail, is in good order, and has as yet required but little new material in the repairs; all that was needed, has been the adjusting the sills and cleaning the ditches in order to drain and keep the road dry.

The whole road is now nearly completed: when finished, it will be in better order and safer for traveling than it ever has been since its construction, and will not suffer in comparison with the best roads of the kind in the country. The Company will then be enabled to run the whole road from Dillerville to Harrisburg in less than two hours; and there is no doubt, with this improved condition of the road, by judicious management, a saving may be made to the Company of more

than ten thousand dollars in the next year's expenses, in repairs of road, passenger and baggage cars, in fuel, and in the wear and tear of machinery.

The *Bridges* across the Big and Little Chickesalunga and the Conewago streams are in very fair order: they will, however, want new flooring as a better protection to the timber from the weather and fire.

The Company have contracted for, and are now building under the bridge over the Swatara creek, two additional and substantial stone piers, to be finished by the first day of November next. This bridge was constructed with but one pier, and is 310 feet long. In consequence of the spans being thus reduced to one-half their former length, the Company will be enabled, without materially obstructing the business of the road, to rebuild the bridge in a more substantial manner, in less time and at less cost, than to have it built on the old pier.

The *Bridge* over the Pennsylvania Canal above Middletown, has been rebuilt; it is now a good and substantial structure.

The *New Bridge* across Paxton's creek, which was carried from its place by the late freshet, has been replaced and repaired; it is now in excellent order. The small bridges and the culverts, on the line of the road, which were all likewise more or less injured by the freshet, have also been rebuilt or put in good repair.

The *Tunnel* is in good order; it is kept free from obstructions, and will require but little to keep it in repair.

The *Locomotives* now in use are in very good order, considering the time they have been running on the road. Two of them, the Henry Clay and C. B. Penrose, have lately undergone a thorough repair; both have been furnished with new fire boxes, flues, &c., and are now in excellent condition: they are considered nearly as good as new, and unless an accident happens, will require but little or no repair for a considerable time.

The *Passenger* and *Baggage cars* have been repaired and improved during the last year, and are now in excellent order.

The *Real Estate* belonging to the Company at Harrisburg, consists of car house and offices, machine shop and depot, five ware-houses with water slips, extra water slip, wharf, and two lots. The buildings are all rented, or in use by the Company, with the exception of two of the warehouses. The rents for the present year amount to one thousand seven hundred and fifty dollars. The company have also several lots of ground and water houses, at Dillerville, Elizabethtown and Middletown, which are now used and occupied as water and wood stations.

The *Weigh Scales* at Harrisburg, which have been out of use for some time, have been taken up, and replaced with new scales, at a point on the road more convenient for weighing; these scales were manufactured by Messrs. Ellicott & Abbot, and weigh over twenty tons: so far as they have been tested for correctness and strength, they fully meet the expectations of the Board of Directors.

It will be seen by reference to the tables, and by comparing the statements annexed, with the last year's business, that the receipts for passengers alone have increased $5478.66, and that for the same time

the receipts for freight have increased $7856.42; making the total increased receipts for passengers and freight of $13,335.08 in favor of the present fiscal year over the last.

Statement of the whole Receipts and Expenditures of the Road and Company for the Fiscal Year, commencing September 1st, 1845, and ending August 31st, 1846; also with the balances of Cash on hand, taken from the Accounts of the Trustees, Treasurer and Superintendent.

1845.		
Sept. 1.	To cash on hand, - - -	$2,933 67
	To cash received from passengers, freight, mails and rents, - - - -	91,703 43
	To cash received from sale of old materials,	1,005 00
	To " " Company's stock, authorized by Act of Assembly, -	40,000 00
	To cash received from sale of T rail-road iron,	3,412 50
	To cash received from Messrs. Craige and Roberts, attorneys, - - - -	2,820 00
	To cash received from sundries, - -	39 39
		$141,913 99
	Disbursed as follows, viz:	
	By cash paid interest on Company's loans,	$35,343 04
	By cash paid for T rail-road iron, timber for new track, chairs, spikes, &c. - -	41,981 52
	By cash paid this amount of Company's loans and debts, - - - -	14,999 97
	*By cash paid expenses proper for the road,	31,989 55
	By cash paid S. Craige and A. S. Roberts, attorneys, on account of the assignment, -	8,820 00
	By cash paid expenses of trust, - -	1,050 00
	By cash paid on account of salary of President and Secretary, office rent, &c. - -	2,564 14
1846.		
Sept. 1.	By cash in hands Treasurer and Trustees, -	5,165 77
		$141,913 99

For a more detailed statement of the receipts and expenditures reference may be had to the annexed statements, No. IV, V, and VI.

Abstract of Receipts from Passengers, Freight, Mails, Rents, &c. for the past Year.

Receipts from	passengers, - - -	$60,538 83
Do.	freight, - - - - -	23,509 97
Do.	mails, - - - - -	6,300 00
	Amount forward	$90,348 80

*The expenses for the month of August are not included in the above item.

Amount brought forward		$90,348 80
Receipts from rents,		1,750 00
Do. sale of old materials,		1,005 00
Total income for last year,		$93,103 80

The statement shows that the receipts for passengers is $60,538.83, equal to $1.38 on an average for each through passenger. The number of miles traveled by passengers is 1,567,056, being equal to 44,337½ through passengers.

The eastward tolls on freight amount to	$11,326 46
The westward tolls on freight amount to	12,183 51
Total, eastward and westward,	$23,509 97

A more detailed statement will be found by reference to Tables Nos. I. and II. annexed to this Report.

The following statement shows the amount and character of the Company's loans and debts; from which it will be seen, by comparing the present statement with the last year's report, that the debts of the Company have decreased more than $20,000 within the last year.

1. Five per cent. sterling bonds, sold in London redeemable in 1858, £64,500 stg. at $4.85,		$312,825 00
2. Six per cent. dollar bonds, issued in United States, redeemable in 1858,		236,300 00
3. Certificates, letter F, for fractional amounts, convertible into bonds, payable in 1858,		1,567 64
4. Debts funded, for which bonds have not been issued,		17,153 00
Total funded until 1858,		$567,845 64
5. Amount due Salomons, on iron notes,	$38,300 00	
6. Bills Payable, not yet due,	15,043 82	
7. Certificates payable, not yet due,	2,200 00	
		55,543 82
8. Certificates payable, and other claims,		2,507 25
Total,		$625,896 71

Although the amount of revenue derived from the road during the past year is very flattering as regards the future prospects of the Company, while the expenses proper have been little more than those of last year; nevertheless, the general expense account will appear heavy, owing in part to the appropriation made to the reconstruction of the wooden or flat bar track, which was entirely worn out and very unsafe to travel on, and in part to repairs of injuries caused by the great flood in the Susquehanna river in March last. On this occasion the water rose to an unprecedented height, carrying away and destroying more than a mile of the Company's road, displacing the new bridge over Paxton's creek, and injuring more or less nearly all the culverts and

road bridges on the line between Elizabethtown and Harrisburg, some of which had to be entirely renewed. By the indefatigable exertions of the Company's superintendents, viz. Messrs. William P. Beatty and Kirk Few, the whole road was, however, put in traveling order in less than a week from the time the repairs commenced.

In closing this Report to the Stockholders, the Board of Directors have not ventured any estimate of revenue for the ensuing year; but they flatter themselves, from the increase of receipts of the present year over the last, under circumstances so manifestly unfavorable to the Company, that when the road is completed and the assignment removed, the nett receipts will be amply adequate, after paying interest on all the loans and debts of the Company, to pay a fair dividend to the Stockholders.

All of which is respectfully submitted.

By order of the Board of Directors,

JOSEPH YEAGER, *President.*

September 4th, 1846.

No. VI.

Statement of the Amount of Expenses incurred by Superintendent, from September 1st, 1845, to September 1st, 1846.

1.	Repairs of roadway, bridges and superstructure, between Elizabethtown and Dillerville, 18 miles iron track,	$1,025 68
2.	Repairs of roadway, bridges and superstructure, between Elizabethtown and Harrisburg, 18 miles wooden, or flat bar, track,	7,224 33
3.	Repairs and improvements of depots, machine shops, warehouses, water stations and new weigh scales,	579 75
4.	Repairs of locomotives and tenders,	3,642 48
5.	Repairs of passenger and baggage cars,	1,698 49
6.	Wood,	4,468 15
7.	Coal,	333 45
8.	Oil and cotton waste,	868 46
9.	Wages of engineers and firemen,	4,117 00
10.	Wages of laborers engaged in pumping water, tending switches, sawing wood, watching bridges and depots,	2,251 58
11.	Carrying passengers in flood and mails to post offices,	466 85
12.	Removing snow from track,	87 93
13.	Insurance on Harrisburg property and taxes,	755 64
14.	Attorney's fees and legal expenses,	517 06
15.	Printing and stationery,	161 07
16.	Salaries of superintendents, collectors and conductors,	3,875 68
17.	Rent of engines and cars to D. Lapsley, trustee,	1,800 00
18.	Old debts paid, incurred prior to Sept. 7th, 1842,	32 96
19.	Damages by flood, &c.	396 56
20.	Amount paid for materials and labor in reconstructing the Company's road,	21,787 91
		$56,100 82

Extract from the Report of the Directors of the West Flanders Railway, to the Shareholders.

Railway traffic has rarely been found to fall short of the estimates, where such estimates have been based on any reasonable principle; but it is in the cost of works that the great errors have been committed. It is therefore an important feature in this undertaking, that the works are light throughout, and liable to none of those contingencies, which, where heavy works are to be executed, must arise, and which disturb and frequently render nugatory, the most careful calculations. They have also with much care revised their calculations with reference to traffic, availing themselves of the information which the accumulated experience on the Belgian lines affords. In this examination they have been materially assisted by the statistical returns of the Government lines, and by a work of M. Desart, the Government Engineer and Divisional Inspector, recently printed. The results brought out by this examination have, in the judgment of the Directors, a most material bearing on the case of the West Flanders lines, and they tend to confirm, in a remarkable manner, the principles on which the lines were adopted, and on which their success was anticipated. The Directors consider it therefore desirable to give them at some length to the Proprietors. The statements worked out from the Government traffic returns establish, beyond all doubt, the following principles, viz.: that the number of passengers between two towns connected by a railway does not depend only on the population or commercial importance of those towns, but most materially on the distance between them. Thus the number of passengers will be greater on a line connecting a succession of small towns and villages, situated as they generally are in England and Belgium, than on a line of equal length connecting two large towns. In proof of this, during the year 1845, Brussels sent—

Passengers.		Kilometres.			Miles.
57,726	to Vilvorde,	10	distant,	about	6¼
76,232	" Malines,	20	"	"	12½
94,698	" Antwerp,	44	"	"	27½
38,359	" Louvain,	44	"	"	27½
14,717	" Termonde,	47	"	"	29½
11,000	" Terlemont,	62	"	"	38½
39,443	" Ghent,	76	"	"	47½
4,732	" St. Trond,	86	"	"	53½
21,322	" Liege,	114	"	"	76½
4,147	" Courtrai,	120	"	"	74½
6,177	" Bruges,	121	"	"	75
2,200	" Vervieres,	139	"	"	86½
3,283	" Tournay,	151	"	"	93½

Brussels, it is shown, sent 57,726 passengers to Vilvorde, a town of 4,000 inhabitants, and of no commercial importance, but only 10 kilometres (about 6¼ miles) distant; 76,232 passengers to Malines, a town with a population of 24,000, and of very small commercial impor-

tance, but only 20 kilometres from Brussels (about 12½ miles); 38,359 passengers to Louvain, a town quite as important as Malines, with equal population, but 44 kilometres (about 27¼ miles) from Brussels, more than twice the distance between Brussels and Malines; and 39,443 passengers to Ghent, a town with a population of 96,000 inhabitants, and of great commercial importance. The number of passengers are thus about the same between Brussels and Ghent as between Brussels and Louvain. It has already been observed that Louvain is unfavorably situated with regard to distance, being 44 kilometres (about 27¼ miles) from Brussels. The number of passengers between Brussels and Ghent was not above half as many as between Brussels and Malines. The reason is, that Ghent is 76 kilometres (about 47¼ miles) from Brussels, and Malines only 20 (about 6¼ miles.) Again in 1845, Malines (24,000 inhabitants) sent—

		Kilometres.		Miles.
32,448 passengers to	Antwerp,	24	distant, about	15
5,218 "	Termonde,	27	" "	16¾
7,028 "	Ghent,	55	" "	34¼
757 "	Bruges,	100	" "	62

But what is more striking is, that Ghent, with its population of 96,000, and great commercial importance, should, in the year 1845 have sent only 13,439 passengers to Antwerp, a town of 78,000 inhabitants, and also of great commercial importance. These two towns being, as M. Desart remarks, the Manchester and Liverpool of Belgium. On the other hand, Malines, comparatively unimportant, sent 32,448 passengers to Antwerp. The explanation is, that Ghent is 79 kilometres (about 49¼ miles) from Antwerp and the railway most circuitous; and Malines is distant only 24 kilometres (about 15 miles). As a further illustration:—Suppose Ghent, which is ten times as important a place as Termonde, to be at the same distance from Brussels as Termonde is, viz., 47 kilometres (about 29¼ miles), Brussels ought to send ten times as many passengers to Ghent as it now does to Termonde, that is to say 14,717 multiplied by ten, or 147,170; whereas in 1845, Brussels, with its population of 140,000, and its importance as capital of Belgium, sent only 31,443 passengers to Ghent. Such a result can only be accounted for by the respective distances between the places connected by the State Railway. Mons. Desart has reduced these facts to a system. By calculations founded on the population and situations of the towns and villages connected by the Government railways, and on the number of passengers moving between the different stations, he has succeeded in forming a table, showing the average number of passengers on the State lines from 2 kilometres (about 1¼ mile) to 250 kilometres distance (about 155½ miles.) According to this table, which is drawn up with great care, the number of passengers goes on increasing at a very rapid rate from 2 to 9 kilometres (between 1 and 5 miles.) The climax is at 9 kilometres (about 5½ miles.) From that distance the number diminishes. When the distance between two places is excessively small, the number of passengers by railway is also small. The most productive distance consequently is from 8 to 10 kilometres (between five and six miles.)

Railway Mag.

Account of Experiments with the New Locomotive Engine "the Great Western."

On June 13th an experimental trip was made on the Great Western, from London to Bristol and back, for the purpose of trying the tractive powers of the new monster engine "The Great Western." The train weighed 100 tons, and consisted of ten first class carriages, seven of which were ballasted with iron, the other three being occupied by the directors and those interested in the experiment.

The train started from Paddington at 11 hour 47 min. 52 sec. It passed the 1st mile-post at 11 hour 51 min. 1 sec., and came abreast of the 52nd mile (immediately after which the breaks were put on for the stoppage at Didcot), at 12 hour 45 min. 24 sec., running, therefore, the 51 miles, with a rise of 118 feet, in a few seconds over 54 minutes, or at an average speed of upwards of 56 miles an hour.

At Didcot a stoppage of 5 min. 15 sec. took place. The mile-post beyond Didcot, viz. the 54th, was passed at 12 hour 54 min. 27 sec., and the 75th mile-post (just after passing which the breaks were put on for the stoppage at Swindon) was reached at 1 hour 18 min. 6 sec., the distance of 21 miles having been passed over in 23 min. 39 sec., or at the average rate of upwards of 54 miles an hour.

At Swindon there was a stoppage of 4 min. 27 sec. The 78th mile-post was passed at 1 hour 29 min. 30 sec., and the 98th mile-post, which is a short distance on the Paddington side of the Box Tunnel, was reached at 1 hour 49 min. 26 sec., the 20 miles having therefore been accomplished in 19 min. 56 sec., or at upwards of a mile per minute. The train came abreast of the 117th mile post at 2 hour 12 min. 3 sec. This gives the time occupied in running the distance between the 78th and 117th as 42 min. 33 sec. for the 39 miles, or something like 53 miles per hour.

The maximum speed on the down journey was obtained between the 83rd and 92nd mile-posts. From the 80th to the 84th mile there is a falling gradient of 8 feet per mile, and from the 85½ to about the 86½ mile there is a falling gradient of about 1 in 100, and a fall of 8 feet per mile then reaches to about the 90½ mile-post; a rising gradient of 8 feet per mile then succeeds, and extends beyond the 22nd mile-post. The train came abreast of the 83rd mile-post at 1 hour 34 min. 56 sec., and passed the 92nd mile-post at 1 hour 43 min. 8 sec., performing the 10 miles in 9 min. and 8 sec., or at an average speed of nearly 66 miles per hour. The 87th and 88th miles, on a fallen gradient of 8 feet per mile, were run over at the rate of *sixty-nine* miles per hour.

The train arrived at Bristol about 15 min. past 2. thereby making the time occupied in starting from a state of rest to coming to a state of rest, or, in other words, from platform to platform, 2 hours 26 min., including stoppages, which averages a rate of 50 miles per hour.

At Bristol, a collation awaited the invited guests, Mr. C. Russel, M. P., in the chair. In the course of his speech he took occasion to remark that a greater speed might have been attained, had not one of the pumps for supplying the boiler with water given way shortly after passing Slough, to remedy which they were under the necessity

of reducing the pressure in the boilers. The train afterwards returned to London. Mr. Brunel drove the engine both ways.

The principal dimensions of this great locomotive are—Cylinders, 18 in. diam. and 2 ft. stroke; driving wheels, 8 ft. diam,; supporting wheels, 4 ft. 6 in. diam.; has six wheels and uncoupled; 278 tubes, 9 ft. long and 2 in. diam.; fire-box outside, 5 ft. 6 in. by 6 ft., inside, 4 ft. 10 in. by 5 ft. 4 in., with a partition through the middle, giving 169 ft. of heating surface, and 20 ft. for area of fire-grate; total heating surface, 1750 ft.; from level of rail to top of cylindrical part of boiler, 9 ft. 6 in.; and from level of rail to top of chimney, 14 ft. 8 in.; supporting wheels 16 ft. apart, with the driving wheels in the centre; total length of engine, 24 ft.; tender on six wheels; weight of engine, 30 tons; tender, 15 tons. Civ. Eng. & Arc. Jour.

History of the Railway Gauge.

In England 1900 miles have been constructed on the narrow gauge, and 274 on the broad. No public railways in England are at present laid down on an intermediate gauge, those which formerly existed having been reduced to the prevailing dimensions of 4 ft. 8½ in. The mineral railways of England vary from 2 ft. to 4 ft 8½ in., the latter only being worked by steam. In Scotland the passenger gauge is 4 ft. 8½ in. In Ireland, under the advice of a Goverment Commission, 5 ft. 3 in. has been adopted as the national gauge, although some short lines have been laid down on 4 ft. 8½ in. In France the railways are, under Government instructions, universally laid down on the narrow gauge. In Belgium the first series of railways laid down by Government were all on the 4 ft. 8½ in. gauge with the exception of one line between Ghent and Antwerp, which is laid down on a gauge of 3 ft. 9 in. In Brunswick the railroads are on the narrow gauge, as they also are in Saxony, Austria, and Bavaria. In Italy, between Leghorn and Pisa, there is a narrow gauge line, and those lines which are being constructed between Genoa and Turin are also on the narrow gauge. In Holland a gauge of 6 ft. 4 or 6 in. has been employed, and in Baden a 5 ft. 3 in. gauge. The railway between Basle and Strasburg is on a gauge of 6 ft. 3 in.—*The Railway System Illustrated.* Min. Jour.

Railway Speculation in 1845.

A curious document has come to light, in the shape of a report from the Registrar-General of Joint Stock Companies to the Privy Council for Trade, for 1845. It forms a gigantic index of upwards of 50 folios to the doings in railway speculation for the past year, and can be likened, in its length and curious disclosures, to nothing else but the ramifications of a Welsh pedigree, or Homer's catalogue of ships. An interesting biography, or book, upon bubbles might be wrought out of it in the hands of a judicious selector. It is, moreover, a mirror of that memorable period of national hallucination when every bubble

was invested with a value, as the true offspring of the joint-stock genius of England, by the then reigning epidemic of speculative cupidity and caprice. In the return every scheme is impaled as nicely as ephemera in the folios of a naturalist. Each scheme is accurately named and numbered so that all whom it concerns may take notice, and see how the multiplied schemes that came out starred with premiums have given up the ghost of a moonshine existence, and found a place in the catalogue of all defunct things. This list is an eloquent *éloge* of the wild spirit of project and speculation that characterised the past, and will be highly useful to the posterity of speculators and projectors in all time to come. The report is but a record of the establishment of the evil of a plethoric speculation, without at all unveiling the disastrous and uncalculating consequences that followed the most puissant period of speculation in the world's history; consequences that can only be adequately arrived at by diving into the depths of woe and Whitecross street, which is said to be half peopled with speculators and projectors, who had a chief hand in the late railway game of hazard. The list consists of 53 pages, and contains the titles and specifications of 1520 schemes, the offspring of 1845—the majority being for railways, water companies, banks, insurances, mines, and an immensity of other joint-stock corporations. The year opened with a mere handful, but, as the days rolled on and the fever became fiercer, they doubled, trebled, and quintupled in quantity, until, in September, October, and November, they came thickly thundering on, at the rate of from 100 to 300 and 500 a-month, and an average in September—the most prolific of all months—of from 16 to 46 each day, or 457 in the month, as will be seen by the following analysis of the return. In December, when the panic rang the tocsin of alarm, and the excitement was gradually subsiding, the climacteric was 31.

The following shows the number of projects registered each month, with the aggregate totals for the same:—

	No. Registered.	*Total.*		*No. Registered.*	*Total.*
January	16	16	July	91	401
February	30	46	August	175	573
March	25	73	September	457	1035
April	53	126	October	363	1401
May	81	218	November	86	1488
June	90	309	December	31	1520

Total schemes registered from January to December 1520

The Gauge Commission.

Analysis of Evidence given before the Royal Commissioners appointed to investigate the subject of the diversity of Railway Gauges.

Continued from Page 234.

Joseph Locke, Esq.—is the engineer who completed the Grand Junction Railway. This line was opened to the public in 1837. When

witness assumed the office of engineer on this line, the rails and sleepers had been contracted for, the bridges designed, and some portion of the work commenced for the narrow gauge. Alteration of gauge at this time would have been attended with considerable expense; narrow gauge selected for this line because surrounded on all sides with lines of similar gauge, and it was desirable to preserve uniformity of gauge in the district. Great Western Railway not commenced at this time. Narrow gauge rails may be laid down on a broad gauge railroad, so as to carry on the narrow gauge traffic continuously; this process is very expensive, and in reference to the stations, very inconvenient. Where two gauges meet, the station by this plan must not only be made larger but also of a different construction than if made for one gauge only. If called upon to project a series of railroads in a new country, would prefer an intermediate gauge, between 4 feet 8½ inches and 7 feet; wide gauge not necessary for machinery; carriages on narrow gauge lines can be made longer and loftier than at present, giving as much space to each passenger, three on a seat, as in those of the broad gauge, four or five on a seat.

Height of carriages on narrow gauge lines lately increased 6 or 8 inches. At high speeds higher wheels are necessary; the centre of gravity would consequently be raised, rendering wider gauge than 4 feet 8½ inches desirable; at the same time, witness is of opinion, that looking to the construction of the road, the speed now attained is as great as is consistent with safety, and would neither increase the gauge, speed, nor size of wheels without more experience in the construction of engines and strength of materials; inequalities of road from change of temperature and weather impossible to be overcome; some engines on South Western Railway with wheels 6 feet 6 inches diameter, where the boilers are not higher than on engines with wheels 5 feet 6 inches; this done by placing the cylinder outside the boiler, and bringing the boiler nearly on to the axle; the centre of gravity as low with the large wheels as the small ones by this arrangement. No disadvantage caused from this change; application of power outside the wheel does not produce a rocking motion. Great changes have been made on engines on narrow gauge lines, with a view to obtain increased power; engines of enormous power have recently been constructed on North Midland Railway to carry heavy trains of minerals. Limited space between wheels and boiler in engines on narrow gauge lines caused some inconvenience in the attempts to obtain increased power. Turned his attention to improving the engine and altering the arrangement of machinery; and now gets all necessary power on narrow gauge lines. Length of boilers on Grand Junction and South Western lines increased from 8 feet 6 to 9 feet 6.

Cannot tell the velocity attained upon the Great Western; express trains on South Western line travel 40 miles, and could no doubt run 50 miles an hour. Does not think 50 miles an hour can be done with safety on any line that witness has been on; is much opposed to such excessive speed. Curves more difficult to traverse with broad than

narrow gauge. Facility for turning curves in inverse ratio to the width of gauge.

Broad gauge gives greater facility for conveyance of heavy trains, by giving larger space to put the power in, but witness considers that as much and even more power than is necessary can be obtained on the narrow gauge; disapproves of throwing a large force upon one engine. Has heard of trains of 60 and 70, and in one instance of 77 wagons in one train; would altogether prohibit such trains; would divide them, and not allow more than 40 wagons, each weighing 5 or 6 tons, at one time; more than that number strains the wagons, the frames are thrown out of square, the chains are broken, and cause delay and inconvenience on the road. Would not have greater power than sufficient to drag 60 wagons; the engines on North Midland, with large boilers, cylinders, and fire-boxes, can drag 100 wagons; they generate more steam than they consume.

Wide gauge more expensive than narrow; it required longer sleepers, greater space for embankments, cuttings, &c.; Mr. Brunel of a contrary opinion; his calculations were founded upon using smaller timbers and lighter rails than he is now using. The South Western rail is 75 lb. to the yard; both the Grand Junction and the London and Birmingham were originally 65 lb.; have been recently increased to 75 lb. Increased expense of broad gauge would be in bridges, tunnels, cuttings, and embankments. Outside rail of Great Western nearer the slope or ditch than upon other lines; if engines get off the lines, more liable to fall over; witness prefers a wide embankment, and where possible, always gives addditional width. Estimates that a broad gauge transverse sleeper would cost 59 per cent. more than a similar sleeper on the narrow gauge. Ordinary width of embankments 30 feet, giving 7 feet on each side between edge and outer rail. In such roads, if engine got off one rail, it would remain on embankment; if off both rails, it would go over. Cannot say how far the extra width in Great Western engines would prevent them getting over the embankment. Would give a space of 7 feet beyond the rails in wide as well as narrow gauge lines.

Rails laid upon longitudinal bearings give greater elasticity to the work, and tend to throw the engines and carriages off the line; tried with longitudinal bearings two viaducts, Dutton viaduct, and Birmingham viaduct, and could never keep them in order; considers the principle bad; prefers transverse sleepers. This opinion the result of actual observation. Railways laid with transverse sleepers more easily repaired than a longitudinal road.

Has not seen the contrivances used at Paddington for transferring traffic from one gauge to another. Believes the transfer can easily be made. The machine itself very simple; the practical difficulty is in use of carriages carrying loose-box bodies to be transferred; a machine was formerly used on Liverpool and Manchester for lifting loose coal-boxes; machine excellent, and saved much labor, but the boxes were so much broken and injured in lifting, that the contrivance was abandoned; carriages with loose bodies are not so strong as others; in event of collision passengers would be in more danger in such car-

riages. On certain French lines the diligences are put on loose wheels, placed under the frame, and with a little hoist lifted upon the body of the carriage, and put upon the truck of the railway, just in the same way as a gentleman's carriage, and taken off in the same manner, and dropped on to a frame of four wheels at the end of the journey. The contrivance is very simple and very facile; but not very safe. They take the truck as it stands when the diligence is loaded; there is first of all a truck made for the diligence. It is not a truck with a simple bottom to it, but has sides to it, and it is then like an ordinary truck; and I believe that when the diligence is upon the track, it is certainly not so strong as if it were part of the same carriage, but it is very heavy, and they carry a weight upon the Paris and Rouen line of eight or nine tons where the diligence is loaded; and if it were not for the change, you might have a weight of only about five or six tons, so that in every carriage you are carrying a great deal of dead weight in order to avoid the necessity of changing the carriages. There was a collision on the Orleans Railway by some sudden stoppage; one of those very diligences was thrown off its position.

Engines on narrow gauge lines are not all made with outside cylinders; on Grand Junction line, about one-half are so made, and others, as they are repaired, are altered upon the new system; but even with cranked axles, the arrangements of machinery are so simplified and compressed, that no inconvenience is felt from want of space. No difference in construction of horse boxes on broad and narrow-gauge lines. Greater speed on Great Western attributed to their having better gradients, fewer stoppages, and larger engines than on narrow gauge. Has traveled on an engine with 6 feet 6 inch wheel (the largest wheel on narrow gauge) 50 miles an hour with ease; that engine capable of taking six or eight carriages 60 miles an hour; one of the new engines on Grand Junction, with only a 6 feet wheel, and expansive gear, recently traveled 57 miles an hour.

Believes that wherever a break of gauge occurs hereafter, either an entirely new line must be laid down, or a narrow gauge line laid upon broad gauge road. In the latter case, continuing the narrow gauge, and having the double gauge upon the shortest possible length, is the lesser evil of the two, and in all probability will be universally adopted. Break of gauge should take place where there is little traffic. An alteration of all the broad gauge lines to 4 feet 8½ inch gauge would be the cheapest mode of obviating the evil of different gauges. Believes the Great Western Company will find the inconvenience of break of gauge so great, that they will be compelled to lay down the narrow gauge from Oxford to London. Is not prepared to say at once that a change of broad to narrow gauge throughout would lead to the greatest economy, and greatest commercial advantage, because the officers of the Great Western Railway believe that the inconveniences attending a change of gauge are less than supposed by witness; could not, therefore, as a government officer, supposing all the railways now made the property of government, advise a change o broad to narrow gauge without greater experience.

Reason of Engineer of Great Western Railway adopting wide gauge, after the Bill had passed through Parliament, supposed to be a desire to obtain greater speed, a better road, and greater economy of construction; one great item of expense in locomotive engines supposed to be the rapid reciprocation of the piston: and to diminish this was thought very desirable; but the expense of working locomotives on narrow gauge has diminished from 2s. 6d. to 2s., 1s. 4d. down to 10d. per mile run; it is very doubtful if the expense is not just as great on Great Western as on the narrow gauge; Mr. Brunel at first intended using wheels of much larger diameter than are used at present; wheels on Great Western formerly 10 feet in diameter; those now used only 7 feet; only 6 inches larger than those at present working on South Western Railway; the adoption of the broad gauge it was supposed would tend to diminish the working expenses; this result, however, has not yet been proved. Considers that a far higher speed can be obtained on narrow gauge lines than is compatible with safety. If desirable to change gauge of South Western to broad gauge, should take certain length, and use a single line; this is the practice when any substantial repair is in progress; when a mile or mile and a half of rail is taken up, using a single line, and keeping a policeman at each end. The tunnels on South Western line not large enough for broad gauge, and while enlarging these, the traffic must be stopped; the bridges and viaducts would also require alteration.

Has bestowed considerable attention to the construction of locomotives, particularly at the time the difficulty was first experienced in obtaining greater speed on narrow gauge lines. The first engines used on Grand Junction line of very inferior construction; the difficulty of obtaining greater speed on this line first induced witness to turn his attention to improvements in the construction of locomotive engines. Outside cylinders introduced on Kingston and Dublin line without outside frames; by this plan the cylinders overhung the frame too much. On Grand Junction line outside frames were used, but the outside bearings were attached to the front and hind wheels only; the cylinder by being attached to the driving wheels, without the intervention of the outside frame, kept the engine more compact. By this arrangement the width of engine was diminished several inches. Inside cylinder has necessarily a crank axle, and more liable to break; on Grand Junction line, accidents from this cause formerly a source not only of expense but of danger, as the crank broke when the train was in motion, and often threw it off the line. Has not had a single accident from breakage since the introduction of outside cylinders. Engines getting off the line not of frequent occurrence; more so now than formerly, in consequence of the increased speed,

Tenders on Great Western line of greater capacity to contain water than on other lines, and run longer distances without changing. Tenders could be made for narrow gauge lines larger than those on Great Western if considered necessary; tenders upon Great Western line all upon six wheels; on other lines upon four wheels only. The 10-feet driving wheels on Great Western abandoned from the difficulty of getting engines large enough to move the trains at any ordinary speed,

and the further difficulty of stopping them when once started. Wheels of these dimensions not suitable on a line with severe gradients. By increasing the size of the wheel there will be a danger of the springing of the wheel itself on its motion, from the axle not being sufficiently rigid. In going through points or crossings with a very large wheel, a very little force applied to the flanch will spring the wheel unless it is made proportionably strong, and if you do that you will have a wide boss; the bosses are 8 or 10 inches, the spokes are 4 or 5 inches, tapering up to 3 inches at the rim; if you increase it from 6 or 7 feet to 10 feet you must increase the width of your boss, and you will have a very heavy weight and very wide boss. Weight of largest engine on Southampton line, about 17 or 18 tons. No evil will result to the road by increasing the weight of the passenger engines.

Wagons on either gauge can be made to contain 5 tons; in the north of England, where so much more is carried than in the south, small wagons are still adhered to. Wagons upon both lines made to carry 10 tons of coals. Narrow gauge most convenient for side lines running to the pits. Relative cost of working trains at 16 miles and at 40 miles an hour about one-third more. Some engines on Grand Junction line burn 16 lb. of coke per mile. Probable consumption of express trains about 4 or 5 lb. per mile more; on Great Western the consumption is considerably more than this; they have larger and heavier engines; on South Western line the quantity of coke consumed per mile is considerably less than on Great Western.

There would be increased difficulty in the ordinary working as regards the maintenance of way, packing the rails, &c., if the narrow and broad gauge were combined. The easiest mode of maintaining the road would be, where you have the broad gauge, by transverse sleepers, and then putting a single rail upon one single sleeper; that is the best mode of keeping the road in repair: but it is not a good mode of laying the road for two carriages, nor is it convenient for working, because the centre of gravity is not in the same line. If you take two rails between the longitudinal bearings of the wide gauge, you have not space enough to put longitudinal bearings, unless you put them close together: and you cannot ram them; if you ram down one side you will run a risk of elevating the other rail; and in ramming down the inner rail you will run a risk of lifting it up out of the level on the opposite side; in fact, the want of the facility of getting to both sides of the baulk would be found a very serious inconvenience. Would propose, under those circumstances, to lay both rails upon transverse sleepers; and if railways were to be made in that manner, should certainly lay a large sleeper, long enough to take both gauges.

A considerable number of the transverse sleepers upon the Great Western Railway have been changed; their duration is very variable; those not well saturated decay sooner than others; their duration also affected by the nature of the soil. Construction of passenger carriages on Grand Junction line much improved; they are now made stronger and more substantial. They are now made solid instead of

being curved out. This change is adopted partly from economy and partly to obtain greater strength. Liverpool and Manchester Company began with very light carriages, considering that the lighter the carriages the less the draught; on the slightest collision they got out of the square; they have been gradually increased in strength up to the present time; they now weigh about 3 or 3¼ tons, but have not yet adopted the solid frame; cost more from the quantity of iron-work used in their construction. Reasons for the adoption of the solid frame were these:—In the bolt-holes in all these small scantlings of timber not more than 4 inches square, or 4 by 3, on taking a carriage to pieces, you found a little decay; that one corner of the bolt-hole gets a little larger, and there is a little play; consequently it has to be renewed far sooner than if it had been a solid and substantial piece of timber, for the least decay in a small piece of timber renders it unfit for its work, and it must be renewed. Upon seeing this at the Grand Junction workshop at Crewe, witness advised the directors to abandon entirely the construction of the carriages on that plan, and to adopt the solid frame; and they now have carriages with solid frames. Considers the public safety much increased by the alteration. Many engineers entertain a different opinion, and consider that very high velocities may be obtained with much lighter carriages than those now used; Mr. Brunel and Mr. Cubitt are both of opinion, that by the atmospheric system, they will be able to keep the road in better order, use lighter carriages, and go at greater speed than has hitherto been attained on any of the locomotive lines. Witness altogether disapproves of light carriages, and considers that with them accidents are more frequent, and when occurring, more dangerous than with the stronger carriages. Safety of train depends greatly upon weight of engine which draws it. If the engine were a light engine, at the speed at which it sometimes travels, it would leave the rail; but as it is heavy, it gives security to the train behind it. Recent accident on Great Western line, where all the light carriages were more or less damaged, while the strong one, in the same line, was scarcely strained. Sleepers can be renewed on transverse system at much less expense than on continuous bearings. Estimated expense of one mile of permanent way, £4,838:—

		£	s.	d
Rails, 75 lb. per yard	236 tons at £11	2596	0	0
Chairs	56 tons " £9	504	0	0
Sleepers	2 640 " 5s.	660	0	0
Ballast	9,680 yards " 1s. 6d.	726	0	0
Laying Road, including Spikes and Keys, 3520 at 2s.		352	0	0
	Total	4838	0	0

The prices of Rails, Chairs, and Ballast are variable.

Civ. Eng. and Arch. Jour.

(To be continued.)

List of American Patents which issued in the month of October, 1845,—with Exemplifications, by CHARLES M. KELLER, *late Chief Examiner in the United States Patent Office.*

1. For improvements in *Machinery for Making Firkins and other Coopers' work;* William Trapp, Jr., Dryden, New York, October 1.

We are under the necessity of omitting the claim in this instance, as it refers to, and depends entirely on the drawings, which are too complex to justify their publication.

The first section of the claim relates to the manner of turning off the surface of the firkin, or barrel, by means of a tool that slides from end to end, so guided as to follow the bilge of the firkin, the staves of which are held together by a chuck-plate at each end. The second section relates to the mode of chamfering, howelling, and crozing the ends of the barrel, by inserting it in a hollow cylinder, open at each end, to turn it, and then bringing the ends of the staves together by an iron chuck, so that the crozing, &c. tool can be presented to both ends. The third section relates to the crozing tool, which is made with a changeable face plate, to adapt it to both ends of the barrel. The fourth section relates to the peculiar manner of combining the parts constituting the tool for turning off the surface of the barrel. And sections five and six relate to the construction of the tools for howelling and chamfering.

2. For improvements in the *Machine for Breaking and Cleaning Flax and Hemp;* Benjamin B. Smith, Hamilton county, Ohio, October 7.

This machine consists of a series of pairs of rollers, armed with slats arranged spirally, and the inclination of the slats is reversed on each succeeding pair of rollers, so that the action on the hemp or flax shall be reversed when passing from the first to the second pair, and so on. And the feeding rollers, which supply the hemp to the slatted rollers, have a vibratory motion, the effect of which is, alternately, to give the hemp to the slatted rollers and draw it back to strip the broken harl or wood from the fibres.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the combination of a series of pairs of cylinders, each pair having spiral-formed slats or bars on them, the slats in each pair running in contrary directions from that immediately preceding, so as to break the hemp in several directions, as herein set forth.

"I also claim, in combination with the dressing-cylinder or cylinders, the vibrating motion of the feeding rollers, so as to draw the hemp in and out again, as before described."

3. For an improved method of *Moulding Glass Knobs;* George O. Russell, Middletown, Connecticut, October 7.

The following claim fully expresses the nature and object of this improvement.

Claim.—"What I claim as my invention and desire to secure by letters patent, is moulding or casting the socket on a screw former, which can be withdrawn from the glass after it has solidified, and before it contracts sufficiently, by cooling, to split or crack, as described."

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4. For an improvement in the *Inkstand;* Walter Hunt, New York City, New York, assigned to Augustus T. Arrowsmith, of the same place, October 7.

The lower end of the tube which dips in the ink is inclined, and has a flap valve hinged to it, and borne up by springs to exclude the ink from the tube, except when the pen is dipped, which operation opens the valve sufficiently to admit the requisite quantity of ink.

Claim.—"What I claim as my invention in the above described improvement, and desire to secure by letters patent, is the application of an air inclined valve or clapper, having a surface of glass, or other hard, smooth material, in combination with said inclined valve and ink-tube; which valve is forced upwards by means of springs, or otherwise, upon the bottom of the ink-tube, and arranged substantially in the manner and for the purposes above set forth and described."

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5. For an improvement in the *Plough;* Thos. B. Quigley and Harvey Hall, Mansfield, Ohio, October 7.

Claim.—"What we claim as our invention and improvement, and desire to secure by letters patent, is the combination of the adjustable wheel with the adjustable beam, as described."

The beam is made adjustable by turning on the screw that connects with the standard, and its rear end is connected with the handle by an adjusting screw, by the turning of which, the plough is made to take more or less land. The wheel is placed back of the mould-board, and between the heel and wing, and its tread is conical, the larger diameter being towards the land-side, "to crowd the rear of the mould-board from the land, and keep the front of the plough towards the land."

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6. For an improvement in the *Machine for Ruling Paper;* Lewis Edwards, Norwich, Connecticut, October 9.

Claim.—"What I claim as new, and for which I ask letters patent, is the causing the pens to be raised by the edge of the paper, in its passage through the machine, thus causing each sheet to determine the length of its own lines."

The sheets of paper are placed on the apron at the required distances apart, and the motion of the pens, towards or from the paper, is governed by a set of stops hung to an arber, so that when these stops are acted upon by the edges of the sheets, the pens are operated; in this way, the extent of the lines is regulated by the spaces between the sheets.

7. For an improvement in the *Process of Manufacturing the Chromate of Potash;* Isaac Tyson, Jr., Baltimore, Maryland, October 9.

Claim.—"Having thus fully described the nature of my improvement in the process of manufacturing the salts of chrome, what I claim therein as new, and desire to secure by letters patent, is the using of wood ashes in mixture with the chrome ore, and with the alkaline salt, for the purpose and in the manner herein fully set forth."

The patentee says:—"My improvement consists in the use of a large proportionate quantity of wood ashes as a substitute for its equivalent of the carbonate of potash, or other alkaline salts; and this substitution is not made for the mere purpose of lessening the quantity of the alkaline salts of commerce which it may be necessary to employ, but I have proved, by careful experiment, that a larger quantity of the chromate is obtained from a given quantity of the ore, when wood ashes are thus used, than when the whole of the alkali is applied by the salts of commerce; the foreign matter contained in the wood ashes manifestly producing this effect."

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8. For an improvement in the *Planing Machine;* Benjamin Brown, Burlington, Vermont, October 9.

This is for an improvement on what is known as the Woodworth planing machine, and consists in the method of constructing an endless carriage, for feeding the board to the rotating planes. The carriage is made in sections, which are moved by a pinion taking into teeth in the middle of the sections, and at the end of their forward motion, the sections are made to descend by curved planes, and are carried back below, and by the same pinion, and at the other end they are raised in the same manner. A permanent strip, or board, fits in a space formed in each section where the cogs are made, for the purpose of guiding the sections, and to cover the cogs, and complete the surface of the carriage.

Claim.—"Having thus fully described my invention, I wish it to be understood that I do not claim an endless platform, formed of sections, nor do I claim the manner of moving them, they having been before used for a horse-power; but what I do claim as my improvement, and desire to secure by letters patent, is the endless sectional platform or carriage, such as herein described, which forms the bed for planing on in combination with the rotating cutters, in the manner and for the purpose set forth, whether the central bar be used or not; and I also claim the sectional platform or carriage in combination with the central bar, for the purpose and in the manner described."

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9. For improvements in *Friction Rollers*, for the boxes of railroad axles, &c.; Wm. Rowan, Great Britain, October 9.

This is for preventing the end play (and the friction arising therefrom,) of boxes on their axles when friction rollers are employed, by making the ends of the rollers bevelled and working against corresponding bevel flanches at each end, on the box and axle, the bevel be-

ing made with the proper pitch corresponding with the diameter of the axle and the roller, so that the bevel surfaces of the two, as they rotate, shall roll on each other, instead of rubbing.

Claim.—"I do not claim as my invention the employment of a series of rollers connected by rings at each end around the axle, and within a box, as this has long since been done; but what I do claim as my invention and desire to secure by letters patent, is making the ends of such rollers on a bevel or mitre, in combination with shoulders, collars, flanches, rings, or other projections on the axle and on the box or hub, having corresponding bevels or mitres to avoid the rubbing friction at the ends of the rollers, and the more effectually to prevent end play, substantially as herein described."

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10. For an improvement in the *Machine for Planing Shingles;* Joseph S. L. Hunt, Boston, Massachusetts, October 9.

Claim.—"My invention or improvement, and therefore that which I claim, consists in the employment of the perforated plate, in combination with the cutting cylinder and feed cutters; the whole being arranged and operating substantially as set forth."

The "perforated plate" is the bed on which the shingle to be planed is pressed by pressure rollers, as it is fed through the machine, and as the planing cylinder (similar to the common planing machine,) is applied below the bed, it, the bed, is cut out, or "perforated," that the rotating plane may act on the under surface of the shingle. In other words, the "perforated plate" may be called a double bed plate, one on each side of the planing cylinder."

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11. For improvements in *Machinery for Splitting and Driving Shoe Pegs;* John C. Briggs, Saratoga Springs, New York, October 11.

We are again under the necessity of omitting the claim, as numerous drawings would be necessary to enable the reader to understand it. The object of the inventor, however, is to form the pegs and drive them into the shoe by the same operation, appropriate cutters being arranged for this purpose in the driving tube.

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12. For an improvement in the *Spring Latch for Doors;* John Palmer, East Haddam, Connecticut, October 11.

Claim.—"I am fully aware that there is nothing new in the employment of a lever and a connecting bar for the purpose of withdrawing or retracing, or otherwise giving motion to an article of mechanism, and therefore I do not lay claim to such; but that to which I do lay claim, is the combination of a screw-pin with the connecting bar, in such manner as to be applicable to the shank of the knobs, or detachable therefrom, as herein described."

The connexion between the latch bolt and the "shank" or spindle of the knobs, is by means of the "connecting bar," (a common joint link) which is jointed to the back end of the latch bolt, and to a pin that screws into the spindle of the knobs, so that by unscrewing this pin the spindle and bolt can be disconnected.

13. For improvements in the *Machine for Cleaning or Burring Wool;* Thomas S. Washburn, Lowell, Massachusetts, October 11.

Claim.—"I shall therefore claim the peculiar manner in which the grate bars are made, so as to operate in connexion with the cylinders, viz: triangular in cross section, so as to present an acute angular or sharp edge for the teeth of the cylinders to act against, in order to remove the burr or burrs, as described.

"I also claim a toothed fan and grate, in combination with the main and picker cylinders F and G, and grate H, the whole being arranged and used, in connexion with a feeding apparatus, substantially as above described."

There are two picker cylinders, lettered F and G, the teeth of the one (F) take the wool from the feed rollers and carry it around to the second toothed cylinder (G,) which, in turn, delivers it to the fan, the wings of which are provided with bars armed with teeth. The two cylinders and the fan are partly surrounded by concaves of angular bars, the angles being towards the cylinders, that the wool may strike against them as it is carried around.

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14. For an improvement in the *Machine for Cleaning Wool;* Alanson Crane, Lowell, Massachusetts, October 11.

Claim.—"Having thus fully described the nature of my improvement in the manner of constructing the fine comb cylinder of a machine for the burring and cleaning of wool or cotton, what I claim therein as new, and desire to secure by letters patent, is the constructing of said cylinder by covering its periphery with metallic plates of such width as may be desired, and extending from end to end thereof, on which plates grooves or channels are to be cut, and the teeth to be formed on one of their edges, in the manner and for the purpose herein fully made known."

The metal plates are placed on a cylinder like staves, or lags, with a space between each, and then these are grooved in the direction of the periphery, and the edge which is to act on the wool is then bevelled towards the cylinder, which leaves a series of pointed teeth. This is for an improvement on the machine patented by Calvert & Crane, on the 16th of July, 1841.

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15. For an improved method of *Replacing Cars that have run off the track;* Samuel H. Bean, Philadelphia, Pennsylvania, October 11.

Claim.—"What I claim as my invention and which I desire to secure by letters patent, is replacing cars that have run off the track, by drawing them up longitudinal inclined planes, formed on blocks of any suitable material, connected together and placed in front of the several wheels, and thence on the transverse inclined planes formed on said blocks, immediately in front of said longitudinal planes, and terminating on a level with the rails, down which, said wheels are

caused to slide, by the gravity of the car, to their proper positions on the track, as set forth."

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16. For an improvement in the *Self-detaching Link for Connecting Railroad Cars;* Richard Hemming, Boston, Massachusetts, October 11.

The patentee says:—"The nature of my invention consists in providing the link with a segment of a circular flanch above and below, embraced by corresponding recesses in jaws, (one of which is jointed,) in the end of the draft beam in one of the cars, the centre of the circle of the flanches corresponding with any point desired between the two cars, so that the flanches shall slide in the recesses when the cars deviate from a straight line, but shall slide entirely out when either of the cars run off the track."

Claim.—"What I claim as my invention and desire to secure by letters patent, is connecting railroad cars, locomotives, &c., by a link provided with a segment of a circular flanch or flanches, embraced in the manner herein described, which will be liberated when the bodies, thus connected, deviate sufficiently from the line of the road, substantially as described, in combination with a spring joint, as herein described, to facilitate the liberation of the link when the car, &c. leaves the track, by a motion upward or downward, as well as horizontal, as set forth."

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17. For improvements in the *Machine for Cutting Shingles;* A. S. Pelton, Clinton, Connecticut, October 16.

The leading object of this machine is to make shingles with a portion of the length towards the butt, with the two surfaces parallel, instead of making them tapering the whole length, as usual. For this purpose, the carriage that carries the block up to the knife is connected with the operating slides at points between the ends of the block and the middle, so that, as one end is fed up to the knife, the other point of connexion becomes the fulcrum, and thus carries back that end of the block which is beyond the connexion with the slide; hence, all that portion of the block will not be acted on by the knife, and the butt end will be formed as pointed out above.

The slides which operate the carriage are placed in the middle, and are hollowed out to embrace a cylinder whose surface is so formed as to operate these slides alternately. This groove is first diagonal to move forward the slide, and then in the direction of the periphery, to hold the slide still during the operation of the knife, and then diagonal, and so on to the end.

Claim.—"What I claim as my invention and desire to secure by letters patent, is connecting the carriage with the slides (or slide) that operate it, at some points between the middle of its length and the ends of the block, so that at each vibration one end shall be moved forward and the other back, as herein described, to form the shingles with the part towards the butt with parallel faces, as specified.

"I also claim operating the two sliding blocks that carry the carriage, by means of a groove, formed as herein described, in the surface of

one cylinder, so that one of the slides shall remain still whilst the other is moved forward, as described. And, finally, I claim connecting the rod that moves one end of the carriage, with its appropriate slitting block, by means of a slide, governed by an adjustable screw, or other analogous device, for the purpose of adjusting the face of the block or bolt of wood to the knife for the cutting of the first shingle, as described."

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18. For machinery for *Manufacturing Forks;* Samuel H. Gilman, Boston, Massachusetts, October 16.

Claim.—"Having thus fully described the nature and operation of my improved machinery for manufacturing forks and other articles of a like character, what I claim therein as new, and desire to secure by letters patent, is the manner in which I have combined and arranged the respective parts of the machinery for cutting, filing, or dressing the handles, as herein described; that is to say, I claim the manner of arranging and combining the revolving cutters, or files, the pattern by which the form to be given to the handle is governed, the rocking frames which carry the cutters, and the sliding frame, being made to co-operate in their action substantially as set forth.

"In that for dressing the prongs, I claim the combination of the revolving wheels, with their cutters, and with the rests which pass in between said wheels, for the purpose and substantially in the manner herein made known."

In the machine for dressing the handles, there are two cutter or filing wheels, the spindles of which are each hung in a rocking frame, the two being forced towards each other and against a pattern, so that as the carriage carrying the fork passes between the two cutter wheels, they are made to approach and recede, to give the required curve to the handle. And in the machine for dressing the prongs, there are several bevel cutter wheels placed on a shaft, side by side, the toothed surfaces of any two forming a V groove. And the rests that carry the forks and sustain the prongs are so formed as to pass in the grooves formed by the different cutter wheels.

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19. For improvements in *Safe Locks;* William Hall, Boston, Massachusetts, October 16.

Claim.—"I do not claim two series of sliding plates or tumblers, arranged side by side, and the one series having recesses in each plate, and the other series having corresponding projections to enter and move in the said recesses, and the one series being affixed to the main bolt, so as to move back and forth, as well as up and down with it, and having a corresponding series of notches or indents in each of its plates, and one spring catch applied to or affixed upon the main bolt, which spring is thrown, by a suitable projection, from the lock case into one of the notches of each of the several plates, whenever the bolt is shot forward by the key, and out of the same, by a similar contrivance, when the bolt is retracted, (the projections of the front series of

plates being carried so far forward, or out of the recesses of the rear series, when the bolt is thrown forward, or locked, as to permit of the fall or vertical depression of each of the plates of the rear series of plates,) all of which will be found to exist in certain locks heretofore patented or sold; but that which I do claim is my specific improvement thereon, the same consisting in the combination with the main bolt and two series of sliding tumblers, constructed and acting together, as above set forth, of a solid stud, (projecting from the bolt;) the slots (cut as above described, in the tumblers of the front series) and a vibrating or moving plate applied to the main bolt and rear series of tumblers, as specified, the whole being arranged and operating together substantially as herein before explained."

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20. For an improvement in the *Bark Mill;* Isaiah Scudder, assigned to Milo J. Wilton, Broadalbin, New York, October 25, ante-dated April 25th, 1845.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the lower part, or second mill, which receives the bark from the upper and discharges it through the side or bottom of the mill, or both, by the aid of arms or flanches attached to the hub or shaft, which force the bark through grater or double saw teeth, whichever are used."

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21. For an improvement in the *Rotary-Top Cooking Stove;* Henry Stanley, West Poultney, Vermont, October 25.

Claim.—"Having thus fully described the manner in which I now construct my rotary top stove, what I claim as new therein, and desire to secure by letters patent, is the combining with a stove furnished with a rotary top an oven occupying the whole area of the lower part of the stove, and furnished with flues, arranged and governed in the manner herein set forth. I do not claim either the manner of forming the oven, or of arranging the flues, as in itself new; but I claim them only in their combination with the rotary-top stove, by which that stove is rendered much more convenient and efficient than under any former construction thereof."

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22. For improvements in the method of *producing and multiplying Copies of Designs;* Carl F. Baldamus and F. W. Siemens, Berlin, Prussia, October 25.

Claim.—"Having now described the nature of our improvements in producing and multiplying copies of designs, and impressions of printed or written surfaces, we would have it understood that we do not confine ourselves to the details shown and described, provided the peculiar character of the arrangements or processes be retained. We would also have it understood that we make no claim to many of the separate parts herein described, but what we claim is—

"1st. The described process, whereby we transfer by means, of treating the originals with acids of strengths varying with the in-

duration of the ink, and so pressing out the acid as to cause an etching of the blank spaces, and a reversed impression of the original (where protected from the action of the acid) on metallic surfaces.

"2d. The process of reviving the printing ink on originals, by first acting on them with caustic potash on its carbonic and tartaric acid, so as to form cream of tartar in the paper, which prevents the adherence of fresh ink in the blank spaces, while the old ink is left in a state to take up an additional quantity from a roller passed over it.

"3d. The herein described process of preventing the adhesion or sticking of printing ink, during the operation of printing, to any part of the plates which are required to remain blank, by acting upon such blank surfaces with acid preparations of phosphorus."

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23. For improvements in the *Apparatus for Purifying Sugar, &c.*; Ethan Cambell, New York, October 25.

Without drawings, we could not convey to our readers a clear idea of this apparatus, and as the claim refers to, and depends entirely upon the drawings, we are under the necessity of omitting it.

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24. For an improvement in the *Piano Forte;* Edward Badlain, Potsdam, New York, October 25.

Claim.—"Furthermore I claim as my invention the adaptation of the above described shutters in said board that prevents the sound from escaping only at the pleasure of the player on the piano forte; I also claim as my invention the above described arrangement of the shutters, as connected with the pedal, to give the motion of the shutters by the use of the pedal; I claim, also, as my invention, the combining the swell with the piano forte, by means of a covering over the strings, and having shutters in said covering, as above described, so as to confine the sound; and, with the use of the pedal, as above described, the shutters in said board are made to open and shut, gradually or quickly, at the pleasure of the player, and can produce the crescendo and diminuendo tones, or swell in the piano forte, as above described; and, by opening and shutting the shutters quickly, the player can produce the explosive and pressure tones by the above described mode, by the use of the pedal."

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25. For an improved *Composition of Matter for Earthenware, &c.*; Joel Farnum, Stillwater, New York, October 25.

The ingredients are:—Pulverized Ochre, Soap Stone, Ground Marl, each 1 part; Alum dissolved with water, ½ part; Kaolin or Ground Feldspar, Barytes ground fine, Ashes and Brine, each 1-16th part. Mix together well for use.

Claim.—"What I claim as my improvement, or invention, and desire to secure by letters patent, is the combination of materials and proportions, as embraced in this application, for making into various articles that the composition will admit of, by moulding, twining or

pressing, burning, and glazing, which is a great improvement for some articles over clay, in use of ochre."

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26. For an improvement in *Bedstead Fastenings;* Ira Smith, assigned to Adin Gauntz, Chagrin Falls, Ohio, October 25.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the combination of the hook and key, constructed in the manner set forth, crossing each other, and thereby forming a double inclined plane, so that by turning the key they are locked, and the joints drawn tight, as herein described."

The lock is a piece of metal projecting from the ends of the end rail and passing into the post; it is made with curved and inclined surfaces. And the key is another piece of metal projecting from the ends of the side rails, and also entering the post, and crossing the hook. This key has a lip, or projection, which, when turned, catches on to the inclined surface of the hook, and draws the side rail up tight to the post. And it has also an eccentric projection, which acts against a shoulder on the hook, to draw the end rail tight.

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27. For an improvement in the *Machine for Cutting and Grinding Fodder:* Jesse Urmy, Wilmington, Delaware, October 25.

The patentee says:—"The nature of my invention consists in arranging cutters that project at right angles with the face of a wheel called the runner, to which they are attached, for slitting fodder, &c., and another set of knives, parallel with the face of the said wheel, for cutting off, with a beveled edge, provided with oblique teeth, corresponding with a like set of teeth on the permanent plate, for grinding or crushing the material which has been slit and cut, so as to perform continuously the operations of slitting, cutting, and crushing or grinding."

List of American Patents which issued in the month of April, 1842 —*with Exemplifications, by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

1. For an improvement in *Piano Fortes;* Thomas Loud, Philadelphia, Pennsylvania, April 1.

All the parts of the action are attached to, or connected with, a sliding frame governed by a pedal, so that the hammers, by the motion of the pedal, can be so moved as to strike either one or the two strings, to increase or decrease the tone.

Claim.—"What I claim, therefore, as constituting my invention, and desire to secure by letters patent, is the manner herein described in which I have combined and arranged the movable frame to which the action of a square or horizontal piano forte is attached, with the pedal, lever, guides, stops, and springs, so as to cause the action in such a piano forte to move from back to front, or in the direction necessary to govern the hammers, and to cause them to strike upon one

or more strings at pleasure. The whole combination being substantially the same with that herein set forth."

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2. For an improvement in the method of *Supplying Air to all kinds of Furnaces;* Edward A. Stevens, Bordentown, New Jersey, April 1.

Claim.—"Having thus fully described the nature of my invention, and set forth some of the advantages to be derived therefrom, what I claim therein as new, and desire to secure by letters patent, is the combining with a steam engine, or other furnace, an air-tight apartment or fire-room, into which room air is to be forced by means of a suitable blowing apparatus, so as to increase the density or pressure of the air to such extent as may be desired for supplying it in sufficient quantities to the burning fuel; the whole being so constructed and arranged as to effect the purposes, and substantially in the manner, herein set forth."

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3. For an improvement in the *Lock for Mail Bags;* H. C. Jones, Newark, New Jersey, April 1.

The object of this improvement is so to arrange the bolts that they will not liberate the shackle by striking the case of the lock to make them react. This is effected by having two bolts that pass through the shackle in opposite directions—one a sliding bolt (designated in the claim by the letter E,) and the other a turning bolt, (designated by the letter F.)

Claim.—"What I claim as my invention and desire to secure by letters patent, is the combination of the slide bolt and the turning bolt passing through the shackle, constructed and arranged as above described."

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4. For an improvement in the *Cultivator for Cotton;* Wm. A. Rogers, Sommerville, Alabama, April 1.

The frame is triangular, the back end of the beam being attached to the middle of one of the sides of the triangle, and thence passing through the junction of the other two sides. Vertical wooden teeth project downwards from the under face of the three sides of the triangle.

Claim.—"What I claim as my invention and which I desire to secure by letters patent is the manner of arranging the back and side rows of teeth in combination with the frame and beam as above described for cultivating cotton."

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5. For an improvement in *Journal Boxes for oiling Journals;* John Shugert, Elizabeth, Alleghany Co., Pa., April 1.

Claim.—"What I claim as my invention and desire to secure by letters patent, is, the arrangement of the reservoirs of oil on each side of the box, their bottom being on a level with the bottom of the box, and being provided with channels leading thereto, in combination with gudgeons or journals made larger than the shaft next to the box, so

that the oil in the bottom of the box may be high enough for the journal to revolve in, and not leak out of the opening in the box, through which the shaft passes, all as herein described."

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6. For an improvement in the method of *Mounting Looms for Weaving Bolting Cloths*; Rollin White, Williamstown, Orange Co., Vt. April 1.

The patentee says—"In the Weaving of Bolting cloths it is necessary to put one, two, or more twists into the threads which constitute the warp, between each thread of filling, for the purpose of preserving the meshes of such cloth of equal size, by preventing their being forced nearer together, or further apart, either in the process of manufacturing them, or in their subsequent use, than would be compatible with the purpose to which the cloth is to be applied; and have, as I verily believe, devised a mode of effecting this which is more simple than, and equally perfect with, any that has been heretofore adopted. In the loom in which this is effected there is not anything peculiar, the object being attained by the particular manner in which the harness is made to operate on the warp."

Instead of having each warp thread to pass through a loop in a corresponding heddle, as in the usual mode of mounting for other kinds of cloth, every alternate warp thread passes through a heddle, and that heddle passes over the warp thread next to the one that passes through the heddle, so that by each operation these two warps are coiled around each other.

Claim—"Having thus fully described the nature of my invention and shown various modes in which the same may be carried into operation, what I claim as new therein and desire to secure by letters patent, is the within described manner of giving one or more twists to the threads of warp, between each thread of filling in the weaving of bolting cloths or other fabrics in the manufacture of which such twist may be required, the same being effected by passing a portion of the heddles around the threads of warp, substantially in the manner set forth."

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7. For an improvement in the *Coulter of Ploughs;* Howard Deland. Mottsville, Onondaga Co., N. Y., April 1.

Claim—"What I claim as constituting my invention and desire to secure by letters patent, is the combination and employment with a plough of a revolving coulter which is serrated or furnished with teeth around its periphery, so sharpened as to constitute cutting edges and to operate substantially in the manner herein set forth. I do not claim a revolving coulter, which consists of a circular plate with a smooth cutting edge, such having been previously known and used; but limit my claim to the foregoing improvement of forming sharp teeth or serratures around it."

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8. For improvements in *Sofa Bedsteads;* Joel Pratt, Hartford, Ct., April 1.

The following claim indicates clearly the nature of these improvements, except that the "folding ends" are double and open like a book, the folding half of each end when open forming the support for the back of the sofa when it is let down for a bed.

Claim—"What I claim as my invention and which I desire to secure by letters patent is, 1st. constructing the sofa with folding ends so as to admit of being opened to form a support, and head and foot board for the back when let down to form a bed, as described. 2nd. the falling back in combination with the turning rail as described. 3rd. the mode of attaching the turning front rail to the permanent ends in combination with the dove-tailed connexion of the back rail as described, by means of which combination the sofa can be put together and taken to pieces so as to render it portable, as above described."

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9. For improvements in *Saw Mill Dogs;* George Henning, Ithaca, N. York, April 1.

We are under the necessity of omitting the claims in this instance, as they refer to, and are wholly dependent on the drawings which are too complex for insertion, as the patent is only granted for slight improvements on previously known methods of setting logs on the carriages of saw mills.

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10. For an improvement in the *Machine for Cutting Sheet Metal;* Mahon Gregg, Wilmington, Del., April 1.

The sheet of metal to be cut by the rotating shears is placed on a rest connected with a carriage by means of a bolt so that the carriage can move the sheet nearer to, or farther from the shears, whilst the turning of the rest admits of the presentation of the sheet at any desired angle.

Claim:—"What I claim as my invention, and which I desire to secure by letters patent, is the combination of the carriage and turning rest with the circular revolving cutters for cutting sheets of metal to any required angle, as described."

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11. For a combination of Mechanism called the *Naval Automaton;* John Adolphus Etzler, Philadelphia, Pa., April 1.

This invention is intended for a variety of purposes, and is more magnificent in the conception than it ever will be in practical results.

By means of a wind mill, cog wheels, drums, ropes, &c., the force of the wind is to be employed in managing the sail of the vessel which is fan shaped, one half on each side of the mast, so that it can be furled by being drawn up on either side. This limits the application of the wind, the waves are to be differently employed.—Large boards are placed below the keel of the vessel and connected therewith by means of jointed arms, levers, &c. so that as the vessel rises and sinks by the action of the waves, the boards remain uninfluenced and therefore by the connexions give motion to the various connecting arms and levers,

which impel machinery of any kind on board the vessel, as well as paddles for propelling the vessel.

We deem it unnecessary to insert the claim, as the originality of the invention is not likely to be called in question.

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12. For an improved process for *Separating Stearine and Elaine;* John H. Smith, Brooklyn, New York, April 1.

Claim:—"I am aware that alcohol has been used for the purpose of separating elaine and stearine from each other in analytical chemistry; but the lard or other fatty matter consisting of these substances, has, in this case, been dissolved in the heated alcohol and the whole has been suffered to cool together; this process would be altogether inapplicable to manufacturing purposes, as the cost would exceed the value of the product. In my manufacturing process, instead of dissolving the lard in alcohol, I add a small proportionate quantity of the latter to the former, the whole of which is driven off at an early period of the ebullition, but by its presence, or catalytically disposes the elaine and stearine to separate from each other, which they do after long boiling, and subsequent cooling. I do not therefore claim the use of alcohol in separating elaine and stearine from each other, by dissolving the fatty matter in heated alcohol and by subsequently cooling the solution; but what I do claim as my invention and wish to secure by letters patent, is the within described method of effectively promoting their separation, by incorporating alcohol, or highly rectified spirits with the lard in small proportionate quantities, say one gallon, more or less, of such alcohol, or spirit, to eighty gallons of lard, and then boiling the mixture for several hours, by which boiling the whole of the alcohol will be driven off, but will have left the elaine and stearine with a disposition to separate from each other, on subsequent cooling, as herein indicated and made known.

Decision of a Suit brought by ZEBULON PARKER, *in the Circuit Court of the United States, for the District of Ohio, December Term,* 1843, *for an Infringement of his Patent for a Water Wheel, by* WILLIAM HATFIELD.

ZEBULON PARKER,
vs.
WILLIAM HATFIELD. } In Chancery

On motion of complainant's council it is ordered that the complainant have leave to file a supplementary and amended bill in this case. It is further ordered that this case be, and the same is, hereby referred to Catharinus P. Buckingham, Esq., of the county of Knox, as special master, who shall, at the request of either of the parties, witness, at such place as he may deem convenient, such experiments as either of the parties may make in his presence, in relation to the improvements by them respectively claimed, and take such further testimony as either of the parties may offer, or he may deem necessary; notice of the time and place of such experiments, or of the taking of such testimony

shall be in writing, and served so as to allow one day for every twenty-five miles travel: and service on Mr. Delano of Mount Vernon shall be good service on defendant, and service on Mr. Smythe of Newark shall be good service on complainant. And it is further ordered that the said master have power to examine either of the parties under oath, at the request of the other; and that said master report to the next Term the result of such experiments, and the evidence by him taken;—and also his opinion touching the following matters:—

First. Whether the invention claimed by complainant was new and useful; and should he so find, that he then report the particulars in which it is new, and wherein consists its utility.

Secondly. Whether the complainant's patent is valid;—and if not, the reason of its invalidity.

Thirdly. Whether the invention claimed by defendant, or the water wheel made, vended, or used by him is an infringement on complainant's rights under his patent; and if so wherein.

Fourthly. The amount of damage sustained by complainant, by reason of the infringement of his rights under said patent by the defendant; and that he do not omit reporting upon this branch of the inquiry because of his reporting unfavorably to complainant upon the second branch thereof; should he do so.

To the Honorable the Circuit Court of the United States, within and for the Seventh Circuit and District of Ohio.

The report of C. P. Buckingham, special Master Commissioner, appointed in the cause in chancery,—pending in said court, wherein Zebulon Parker is complainant, and William Hatfield is defendant.

The said special Master Commissioner reports to your honorable Court, that in pursuance of the order made in said cause at the December term of said Court, A. D. 1843, he has examined said cause; and that from the pleadings, exhibits, and testimony on file in said cause, he finds:—That on the 19th day of October, 1829, a patent was issued to Zebulon Parker and Austin Parker for "an improvement in the application of hydraulic power," which improvement consists, according to the specification of the patent: 1st. In placing several wheels, (always an even number) on one shaft, and conducting the water to them through spouts which wind between concentric cylinders, producing thereby a whirling or vertical motion of the water in the same direction with that of the wheels; 2nd. In a contrivance for introducing the water into a single horizontal wheel with a circular motion; together with an improvement in the construction of the wheel itself; 3rd. In a contrivance for applying the same principle to common wheels now in use.

At a subsequent period Austin Parker deceased, and his administrator, Robert McKelvey, conveyed to Zebulon Parker all his interest in the invention and subsequent improvements, by deed dated November 2, 1839. On the fourth day of October, 1843, the patent was extended to the term of twenty-one years from its original date, upon the petition of Zebulon Parker.

On the 31st. December, 1838, William Hatfield obtained a patent for an improvement on Parker's percussion and reaction wheel, consisting, according to the specification, of the peculiar form of the buckets, and the double spiral scroll placed between them for directing the water.

In his answer to the bill filed against him by the complainant, the defendant claims that his invention was denominated "an improvement on Parker's percussion and reaction wheel," by mistake, and that the wheel for which he obtained his patent was wholly his own invention.

The first question asked by the Court in their order is, "whether the invention claimed by the complainant was new and useful; and should he so find, that he [the Commissioner] then report the particulars in which it was new, and wherein consisted its utility."

The invention claimed by the complainant consists of several parts or particulars. Each of these will be examined separately. The first particular is the arrangement of several wheels upon the same horizontal shaft. There is nothing in evidence to show that this invention was not *new*. The only evidence on this part of the subject is that of Isaac Dillon, who is uncertain whether the wheels he heard of as being used by George Girty at Dresden on one shaft, was prior to the use of Parker's wheel or not. Next as to its utility. The word useful, as applied to an invention does not necessarily imply an improvement upon all former methods of obtaining the same end. So far as its *comparative* merits are concerned, it is a matter of some importance to the inventor in a pecuniary point of view, because upon this will depend the profits which he may derive from the exclusive right secured to him by his patent; but it is certainly a matter of no importance to the public. The office of the Government in granting a patent is that of *Protection*. It operates on the one hand to secure to the inventor, the benefit of his own talents and industry for a limited period, on condition that at the end of this period these benefits shall be enjoyed by the public at large; and on the other to prevent injury to the public by the encouragement or protection of such inventions as are mischievous in their character. However small may be the *merit* of the invention, the public can be no loser, for the benefit of its protection will be small in proportion. The *character* of the invention then is the only thing which the government has to look to in reference to the public interest; and it is in reference to this, and this alone, that the word useful is applied in the patent; it simply means a capability of being applied to a beneficial purpose, and is opposed to that which is mischievous and injurious in its natural tendency. Mr. Justice Story (in Bradford *vs.* Hunt, 1 Mason 302,) says, "by useful inventions in the statute of 1793, C. 156, is meant such a one as may be applied to some beneficial use in society, in contradistinction to an invention which is injurious to the morals, the health, or the good order of society. It is not necessary to establish that the invention is of such general utility as to supersede all other inventions now in practice to accomplish the same purpose. It is sufficient that it has no noxious or mischievous tendency; that it may be applied to practical uses, and that so far as it is applied it is

salutary. If its practical utility be very limited it will follow that it will be of little or no profit to the inventor, and if it be trifling it will sink into neglect. The law however does not look to the degree of utility, it simply requires that it shall be capable of use, and that the use is such as sound morals and probity do not discountenance or prohibit."

In an action for an infringement of a patent—for an improvement in the construction of pumps the same judge said that, "It was contended by the defendant that it was necessary for the plaintiff to prove that the invention is of general utility; so that in fact for the ordinary purposes of life it must supersede the pump in common use; in short that it must be for the public a better pump than the common pump; and that unless the plaintiff can establish this position, the law will not give him the benefit of his patent, even though in some particular cases his invention might be applied with advantage. I do not so consider the law. The statute 1793, C. 156, uses the word *useful* invention merely incidentally: it occurs only in the first section, and then it seems merely descriptive of the subject matter of the application, or the conviction of the applicant: neither the oath required by the second section, nor the special matter of the defence allowed to be given in evidence by the sixth section of the act, contains any such qualification, or reference to general utility, to establish the validity of the patent; nor is it alluded to in the tenth section as cause for which a patent may be vacated. To be sure all the matters of defence, or of objection to the patent are not enumerated in these sections; but if such a one as that now contended for had been intended, it is scarcely possible to account for its omission. In my judgment the argument is entirely without foundation." (Whittemore *vs.* Cutter, 1 Gallison 429,435.)

In this sense then the invention is certainly *useful*, inasmuch as it is not pretended that it has in any sense a mischievous effect upon the public.

The particulars in which this part of the invention is claimed to be *new* are, the position of the shaft, (being horizontal) and the number of wheels attached thereto. Its utility consists in the convenience of attaching the shaft directly to the saw without the intervention of gearing; in avoiding friction, by placing the wheels in pairs, so that the water will press equally each way in a direction parallel with the shaft, and in permitting the power of a low head as applied to the same shaft to be increased to the utmost extent of the supply of water, by increasing the number of pairs of wheels.

The next particular of the invention claimed by the complainant, to which the first question of the Court will be applied, consists of the concentric cylinders and the manner of supporting them.

No evidence has been adduced to show that this part of the invention is not new, nor can there be a doubt of its utility in the sense which we have assumed as belonging to the word. The particulars in which this part of the invention is claimed to be new, are, a hollow cylinder with an interior diameter nearly equal to that of the wheel,

another cylinder which is solid, (except the cavity for the shaft to run in,) and concentric with the first. These cylinders are placed between the two wheels, and serve to give the water a circular or whirling motion by passing between them before striking the wheels. Connected with these cylinders and essential to them is the manner of supporting them, which is simply by enclosing their ends in plank rims attached to the frame work of the forebay. The utility of these cylinders consists in the whirling or vertical motion which they give to the water before it reaches the wheels. This motion is in the direction in which the wheel moves, and causes the particles of water as they pass out at the issues to act at a greater angle against the inner sides of the buckets. Every wheel propelled by the action of the water upon the inclined surfaces of the buckets placed around its circumference, with issues for the water to pass freely out, may be said to act by percussion. For the particles of water being urged by the pressure of those behind, in endeavoring to escape in every direction, outwardly, act upon these inclined surfaces just as the force of the water is exerted upon the lee board of a boat crossing the stream by the force of the current. Now it is clear that if by any means a direction be given to the current, which shall coincide with that of the boat, before it strikes the board, it will serve to propel the boat faster. This is just the effect of the cylinders in question: but it is by no means clear that the inner one is *essential* to produce this result.

The next particular of the invention claimed by the complainant is "the spouts which conduct the water into the wheels from the penstock, and their spiral terminations between the cylinders."

This part of the invention is, also, both new and useful. The novelty of these spouts consists of their spiral terminations. Their utility consists in their conveying the water more easily and with less friction to the inside of the wheels, where it can act at once upon the buckets.

These particulars have reference in every case to the arrangement of several wheels upon a horizontal shaft; similar particulars are claimed by the complainant in the invention, as applied to single horizontal wheels upon a vertical shaft; and to these particulars the foregoing observations will apply in the same way.

Another part of the invention claimed by the complainant is a contrivance for applying the principle of vertical, or circular motion of the water to reaction wheels now in use. This contrivance is both new and useful in the sense in which those above described are so. Its utility consists in giving to the water a circular motion as it enters the wheel, to act upon the buckets or issues.

The next question proposed by the Court is "whether the complainant's patent is valid." There is nothing in the evidence which goes to show its invalidity. If then it is invalid, it must appear on the face of the patent itself. The two principal considerations to be applied to the question are, whether the invention is one of a nature to entitle the inventor to a patent therefor; and whether the provisions of the law are complied with in the manner of making the specifications. And *First*:—the invention is one which consists mainly of

these parts: 1st, a contrivance for applying the water more advantageously to the buckets of the wheel, by giving it a whirling motion; 2nd, a combination of wheels upon one shaft, for the purpose of increasing power and avoiding friction; 3rd, an improvement in the reaction wheel, by making the buckets as thin at both ends as they safely can be made, and the rim no wider than sufficient to cover them.

By the sixth section of the act of Congress passed July 4th, 1836, it is provided that "any person or persons having discovered or invented any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvement in any art, machine, manufacture, or composition of matter," &c.

The first part of this invention may very properly be denominated a "new and useful machine," being a contrivance consisting of cylinders and their supports with the spiral spouts between. It can be described, made and sold; and each and every part, whether combined or separate, may be made the subject of exclusive right, and is therefore clearly entitled to a patent.

The second part of the invention may properly be called an improvement on a machine, by means of a new combination of things which were before in use and well known. It is true the inventor entitles it "the compound vertical percussion and reaction wheel," but this title is evidently applied to the COMBINATION, since the several parts consisting of the shaft and wheels were well known before.

In the case of Moody *vs.* Fisher 2 Mason 112, Judge Story says, "Where a patent is for a new *combination* of existing machinery, or machines, and does not claim or specify any improvement or invention except the *combination*, proof that the machines or any part of their structure existed before forms no objection to the patent, unless the *combination* has existed before; for that reason the inventor is limited to the combination." This part of the invention has therefore nothing in its nature which destroys the right of the inventor to a patent.

The third part of the invention is the improvement in the reaction wheel by making the buckets as thin at both ends as they can safely be made and the rim no wider than sufficient to cover them.

This part of the invention claimed by the complainant does not seem to be of a character to entitle the inventor to a patent. It is called an *improvement*, but it contains nothing which sufficiently differs from the old wheel to make in any sense a new machine of it. It consists merely of a slight variation or change in the form or proportions of a wheel long in use, without in any way changing the mode by which the water acts upon the wheel, nor the effect of such action. Judge Washington in Gray & Asgood *vs.* James and others, 1 Pet. C. C. R. 396, says, "what constitutes a difference in principle between two machines is frequently a question of difficulty, more especially if the difference in principle is considerable and the machinery complicated. But we think it may safely be laid down as a general rule that where machines are substantially the same, and operate in the same manner to produce the same result, they must be in principle

the same. I say *substantially*, in order to exclude all formal differences, and when I speak of the same result, I must be understood as meaning the same kind of result though it may differ in extent. So that the result is the same, according to this definition, whether one produce more nails for instance in a given time than another, if the operation is to make nails."

This wheel then claimed by the complainant must be considered as substantially the same wheel as the one before in use, and therefore not entitled to a patent.

Secondly :—Is the invention so described in the specification as to correspond with the requirements of the statute? These requirements are, that it shall be in such clear, full and exact terms, avoiding unnecessary prolixity, as to enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, compound and use the same. It would be difficult to imagine a description more clear and distinct than that given of the complainant's invention in the specification of his patent. The form, proportions and mode of construction of every part seem to be as accurately described as the nature of the case will permit. The patent cannot be objected to on this account. The only point of doubt then as to the validity of the patent is, whether that part of the invention said to consist in the "improvement of the reaction *wheel*," not being entitled to a patent, is sufficient to invalidate the whole. Judge Story in Moody *vs.* Fiske, 2 Mason 112, says, "when the patentee claims anything as his own invention in his specifications, Courts of law cannot reject the claim; and if it is included in the patent and found not to be new, the patent is void; however small or unimportant such asserted invention may be; where he sums up the particulars of his invention and his patent covers them, he is confined to such summary: and if some part which he claims in his summing up as his invention proves not to be in fact his invention, he cannot be permitted to sustain his patent by showing that such part is of slight value or importance in his patent. His patent covers it, and if it be not new the patent must be void." Now the alleged improvement in the water wheel consists in a simple change of form of the buckets and the proportions of the rim. This change, though slight and not involving a sufficient difference from the old wheel to form a new machine in any sense, and therefore not entitled to a patent, is nevertheless, so far as there is any alteration, the invention of the complainant, so that he does not claim any thing that he has not invented; though a part of that invention would not be entitled to a patent. The said Commissioner is therefore of opinion that the patent in this respect is valid; though this opinion is expressed with some hesitation.

The third question of the Court is "whether the invention claimed by the defendant, or the water wheel made, vended, or used by him is an infringement of the complainant's rights under his patent, and if so, wherein." The improvements claimed by the defendant in the summing up of his specification, are "the peculiar form of the buckets, and the double spiral scroll placed between them." The specification itself however describes the wheels as placed in pairs on a

horizontal shaft, and the scroll as being placed in a "concave" resembling an ogee. The spiral scroll, the combination of the wheels, and the "concave," are all of them, undoubtedly, infringements on the rights of the complainant under his patent; the two first items being precisely the same as those described in the patent of the complainant, and the "concave" being nothing less than the "outer cylinder" of the complainant, and which principally acts in producing the vertical or whirling motion of the water.

The fourth question of the Court is the amount of damage sustained by the complainant, by reason of the infringement of his rights under said patent, by the defendant.

The only evidence touching the number of wheels made and put into operation by defendant is that of S. R. Chandler, and of Martin Chandler, Jr. The former says that he knows of the defendant building a mill on a fork of Salt Creek, in Muskingum county, and others in the neighborhood; that he has seen the wheels used by Hatfield, and that they are identical with his own (one of complainant's,) except his was made of iron, and those put in by defendant of wood. The latter says, he never saw but three of defendant's wheels in operation, and he thinks there is no material difference between them and complainant's. It would seem then, that no more than three wheels have been proved to have been put into operation by the defendant, the damages for which, at the price demanded by the complainant for each right would amount to seventy five dollars.

In the month of July, 1844, at the request of the complainant, the undersigned notified the parties that he would attend at the house of the complainant for the purpose of witnessing a series of experiments having reference to this cause. Owing to the alleged illness of the defendant he did not attend at the time appointed, and afterwards protested against the experiments made in his absence being used as evidence. In the month of May last, after due notice to both parties, the experiments were repeated, defendant being still absent.

After full investigation of the matter the undersigned became satisfied that the experiments (of which the object was to test the relative merits of complainant's invention) had no bearing upon the question at issue between the parties, and therefore no notice was taken of them in the investigation of the subject.

All of which is respectfully submitted.

C. P. Buckingham,
Special Master Commissioner.

Zebulon Parker,
vs.
William Hatfield. } In Chancery.

This cause came on to be heard on the original, amended and supplemental bills of complainant, the answer of the defendant, the exhibits and testimony, the report of the Special Master herein, and the exceptions thereto; and was argued by counsel. Whereupon the Court, on consideration of the premises, *do find;*—That the said complainant, and the said Austin Parker, deceased, were the original in-

ventors of the said several improvements in said bills mentioned and described. The Court do further find, that letters patent have duly issued from the United States, as set forth in said bills, and that all the rights and exclusive privileges secured thereby have become vested solely in the said complainant. The Court do further find, that the said several improvements, to wit: –1, The application of two, four, six, or more reaction wheels, of iron or wood, on one horizontal shaft, for saw mills and other purposes;—2, The principle of introducing water into reaction wheels, with a vertical or circular motion, by concentric cylinders enclosing the shaft, or other means ;—3, The application of air-tight cases, or boxes, denominated drafts, as enclosures of reaction wheels, as described in the schedule of one of said letters patent, and mentioned in said supplemental bill, are new and useful improvements in the application of hydraulic power. The Court do further find that the letters patent of the defendant set forth in his answer herein, embrace no new or useful improvement, and are therefore *void;* and that the said defendant, in making, using, and vending his supposed improvements, is infringing the rights and exclusive privileges of the said complainant.

It is therefore ordered, adjudged, and decreed by the Court here, that the report of the said Special Master herein be, and the same is hereby, approved and confirmed, and the exceptions thereto be, and the same are hereby, overruled. It is further adjudged and decreed that the several letters patent of the said complainant are good and valid in law, and secure to the said complainant the exclusive right and privilege of making, using, and vending the improvements aforesaid. The Court do further adjudge and decree that the said defendant be, and he is hereby, enjoined from further making, using or vending reaction water wheels to be used in the manner of those heretofore made by him, or any other way infringing the exclusive privileges aforesaid of the said complainant during the time limited in said several letters patent of the said complainant for his use. And it is further ordered, adjudged, and decreed that the said defendant, within twenty days from the rising of this Court, pay the costs of this suit, and in default thereof that execution issue as in cases at law.

(July 24, 1846.)

SPECIFICATIONS OF ENGLISH PATENTS.

Specification of a Patent granted to Rees Davies, *of the county of Brecon, for improvements in the manufacture of Iron.* [Sealed 24th June, 1844.]

This invention consists in so conducting the process of manufacturing iron, when anthracite, stone-coal, or culm is used, that the charge may be caused to enter the blast furnace in an ignited state.

Fig. 1, is a vertical section of a blast-furnace, suitably constructed for carrying out this invention; fig, 2 is a horizontal section, taken on the line 1, 2, of fig. 1; fig. 3, is a vertical section of the furnace,

taken in the direction of the dotted line 3, 4, (fig. 2.); and fig. 4 is a horizontal section, on the line 5, 6, of figs. 1, and 3. *a*, is the part of the furnace in which the blast operates; this part is constructed in a similar manner to the ordinary blast-furnaces from the lower parts up to the boshes, and the blast (whether hot or cold) is applied in the usual way by the tuyeres *b*, *b*. Above the part *a*, the interior of the furnace is contracted, and forms a chimney *c*, to carry off the gases and products of combustion; the charging of the furnace is not effected through the tunnel-head or chimney *c*, but through the passages *d*, *d*, excepting the first charge, which must be made with unignited materials, in the ordinary way. *e*, *e*, are kilns or chambers, into which the charges of iron ore, fuel and flux, are continually introduced and ignited; the upper ends of the chamber are open, to receive the successive portions of the charge, and the lower ends communicate with the furnace *a*, by the passages *d*. *f*, *f*, are openings for stirring the charge and regulating the passage of the descending materials from the chambers *e*, into the furnace. The blast does not act on the charge contained in the chambers *e*; but the anthracite being kept in a state of partial combustion, by the draft of atmospheric air through it from the passages *d*, there will be a previous ignition of the charge going on in the chambers *e*; this is important, as anthracite, stone coal, or culm, which has been ignited before being brought into contact with a blast of air, works more favorably in the manufacture of iron (either with hot or cold blast) than when thrown in a cold state into the blast-furnace; and the ore, after the above process, is in a more suitable state for introduction into the blast-furnace.

Fig. 1.

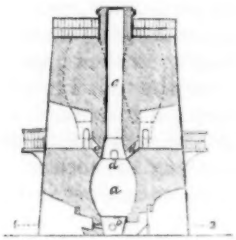


Fig. 3.

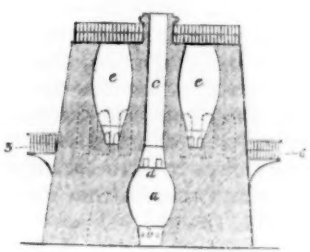


Fig. 2.

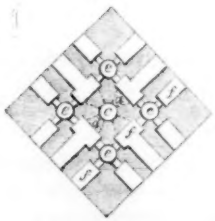


Fig. 4.

The patentee remarks, that although he believes it to be best to use anthracite, stone coal, or culm alone, yet other fuel may be mixed therewith; and that although he has shown the best arrangement of

furnace that he is acquainted with, he does not confine himself thereto, so long as the charge can be supplied to a blast furnace in an ignited state.

He claims the manufacture of iron by means of anthracite, stone coal, or culm (whether used alone or mixed with other fuel), which has been, together with the iron-stone or ore and flux, before its projection into the blast-furnace, brought into a state of ignition by a draft of atmospheric air, in chambers so arranged as not to interfere with the blast-furnace.—*Inrolled December*, 1844.

Lon. Jour of Arts & Sci.

Specification of a Patent granted to Frederick Bankart, *of the county of Surrey, for certain improvements in treating certain Metallic Ores, and refining the Products therefrom.*—Sealed August 7, 1845.

To all to whom these presents shall come, &c., &c.—My invention relates to and includes all metallic ores containing copper, whether in combination with sulphur or not in combination with it, and has for its object to convert the copper into a soluble sulphate of its oxide, and separating it from the foreign admixtures which the ores contain, to obtain it in the refined metallic state, and consists in adjusting and mixing together the different ores before mentioned, in such manner that those ores which hold sulphur in excess may compensate those which are wholly or partially deficient in sulphur; and in submitting the ores, so adjusted and mixed, to successive roastings and lixiviations, whereby a solution of sulphate of copper is obtained, from which the copper may be precipitated in a refined metallic state. And in order that my invention and the means of carrying it into effect may be fully understood, and before proceeding to the description hereinafter contained, I would premise that copper ores, as commonly known, are either sulphurets, oxides, or carbonates, or a mixture of all or some of the above in various proportions; they are also frequently mixed with bisulphuret of iron, or iron pyrites, and sometimes with the sulphurets of zinc and lead, and other foreign ingredients.

The oxides and carbonates contain, respectively, oxygen and carbonic acid, but no sulphur; bisulphuret of iron, or iron pyrites, contains iron and sulphur, and is frequently associated with and forms great part of the sulphur ores of copper, and in the processes hereinafter described, furnishes the sulphur in which the copper sulphurets as well as the oxides and carbonates of copper are deficient; for the conversion of their copper into sulphate and to allow for waste, and for the sake of convenience, I call the sulphur contained in the bisulphuret of iron or iron pyrites, whether naturally combined in the ores of copper or artificially mixed therewith in similar proportions, "sulphur in excess," as existing in a greater proportion than is required to convert the copper contained in the ore into a soluble sulphate of copper. It is well known that no copper ore, except the

copper pyrites or double sulphuret of copper and iron, contain alone sufficient sulphur for the conversion of their copper (when oxidized) into sulphates, whilst the oxides and carbonates do not contain any sulphur. And practically, much of the sulphur which copper ores actually contain, escapes in the form of vapor of sulphur, or sulphurous acid gas and sulphuric acid, and which requires to be replaced from other sources. The sulphur thus deficient is to be supplied by the bisulphuret of iron, or iron pyrites, either naturally associated with the ores of copper, as copper pyrites, or by artificial mixture, previous to putting them into the furnace.

I now proceed to describe the method I use for carrying my invention into effect. I take copper bars, usually sampled and sold, and if not already reduced to powder, I pulverize it, and although this is not absolutely essential, yet upon the greater or less completeness of this operation, depends very much the amount of fuel, labor, and time expended in the various processes hereinafter described. If the character of the ore, with respect to the relative proportions of copper and sulphur, having been ascertained, by analysis of the sulphur, bears a less proportion to the copper than one to two, I add iron pyrites, or copper pyrites, also pulverized, in such quantities as will raise the proportion of the sulphur to the copper in the mixture, to at least that above stated, namely, one to two. If two or more descriptions of copper ores are to be treated as sulphurets, oxides, carbonates or other natural combinations of copper, they are to be mixed together in such proportions as will make the sulphur of the mixture bear to the copper of the mixture at least the proportion of one to two, adding iron or copper pyrites, as before stated, where necessary to ensure at least that proportion of sulphur to copper; and I would observe, that care must always be taken to have a sufficient quantity of sulphur ores for the conversion of the copper into a soluble sulphate of its oxide, and also to allow for the escape of part of the sulphur during the processes, either as vapor of sulphur, or sulphurous acid, or sulphuric acid. The copper ore, prepared and adjusted in the manner before mentioned, is then to be submitted to such a degree of heat, in free contact with atmospheric air, as will oxidize the metals not already in a state of oxide, and convert the sulphur into sulphuric acid. For this purpose I place the ore, or mixtures of ores, in a common reverberatory furnace, and I submit the ore to a dull red heat, in free contact with the atmospheric air, until the mixture attains a state of seeming fluidity, which I find to be most favorable for the decomposition of the ores, and for the conversion of the copper into a sulphate, and I retain the mixture in that state until the evolution of sulphurous vapor nearly ceases. Instead of laying the mixture on the sole floor, or hearth of the furnace, at once, in a bed of from three to four inches in thickness, I prefer, in order to the more speedy accomplishment of the object in view, to divide the mixture into several portions, and having put one portion into the furnace, I add another portion when the first has attained a dull red heat, and the metals are becoming partially oxidized, and I keep repeating these additions, under similar circumstances, until the whole of the ore is put into the furnace,

and I find that by this mode the furnace is neither clogged nor injuriously cooled, and the ore is more rapidly decomposed than when all is put into the furnace at once; whilst the sulphur of the latter portions of ore, from their coming into intermediate contact with the partially oxidized metals, is more readily, and with less waste, converted into sulphuric acid, which, finding oxide of copper ready formed in the first portions of ore, unites with it and forms sulphate of copper. The mixture is frequently stirred, so as to expose fresh surfaces to the atmospheric air for the absorption of oxygen. In this first roasting a part only of the copper is converted into a sulphate, and the remainder, which was not already so, into an oxide; but by repeating the process of roasting the residue mixture, in conjunction with fresh sulphur ore, in the proportions before mentioned for the first roasting, and also hereinafter described, and which may be either before or after lixiviation next described, this remaining oxide of copper will be converted into a sulphate; but I prefer to wash the one after each roasting, in order that a part of the copper may be in a course of precipitation, whilst the remainder is undergoing decomposition in the furnace, as by this means a saving of time is effected.

The evolution of sulphurous vapor having ceased, or nearly so, I remove the mixture from the furnace to an adjoining vat or pit, and apply to it water (or a weak sulphate liquor from a previous lixiviation), of about the boiling temperature, and I retain it at that temperature some little time by means of injected steam, the better to ensure the solution of the sulphate of copper; and, having drawn off the sulphate of copper liquor from the residuum mixture, which I call "insoluble residue," I set the latter aside in readiness for subsequent use, previously drying it, or not, as may be convenient. I next assay this insoluble residue, and determine by analysis the quantity of copper and of sulphur (if any remain unacidified); and I then add iron pyrites, or copper pyrites, in such quantity as will make the quantity of sulphur contained in the mixture at least equal to half the quantity of copper therein. I then return this mixture so adjusted into the furnace, and subject it to a second process of roasting, conducted in a similar manner to the one already described, and continued as before until the sulphurous vapor has ceased to be evolved, or nearly so, and the mixture is then subjected to a second lixiviation, conducted as before described. I repeat this process of adjusting the mixture, roasting, and lixiviation, as hereinbefore described, with the successive residuums, once, twice, or oftener, according to the character of ores under operation; some yielding the whole of their copper to two operations, whilst others may require three or more before the copper is entirely separated. And in the second and subsequent furnace treatments, if the fresh sulphur ore to be used be copper pyrites, and is not already in powder, I prefer to use it in small lumps, by which means I obtain the sulphur more gradually, and make it available with less waste for the formation of sulphate of copper with the smallest residuum; and these lumps being afterwards separated by means of a sieve, and pulverized, are used to charge the furnace afresh. And when the copper ore is all in powder, iron py-

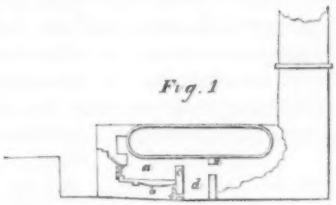
rites should be used for the last roasting, so as to avoid a remainder of copper. The next process is, to precipitate the copper from its sulphate solution, after which it is to be fused, and run into moulds, when it is ready for use or sale, as fine metallic copper. Various known modes of precipitation may be adopted; but I precipitate by means of iron, either cast or wrought metal, which I prefer to be in plates, presenting a larger surface to the action of the liquid, always keeping the solution at a temperature of from about 120° to 150° of Fahrenheit's scale, and as nearly as may be of the same strength, by means of a circulating stream of fresh sulphate solution, which, entering towards the top, and conducted through a pipe downwards, tends to displace by its greater specific gravity the lighter liquid or sulphate of iron, which overflowing is to be returned into the lixiviating vat to be re-charged with sulphate of copper, and this again precipitated, until the refuse liquid becomes a nearly saturated solution of sulphate of iron, when it is set aside to crystalize. The two conditions of high temperature in the sulphate solution, and the maintenance of a fresh circulating stream in the vat, contribute to the rapidity of precipitation, and to preventing the free acid of the sulphate solution from attacking and dissolving the iron beyond its corresponding or proportionate weight of copper precipitated. The sulphurous acid vapors, proceeding from the various roasting processes, hereinbefore described, may, if desired, be condensed either as sulphurous acid, or employed for the manufacture of sulphuric acid, according to various well-known methods.

Having described the nature of my invention, and the method of carrying it into effect, I would remark, that variations may be made in some of the arrangements and details without departing from my invention, so long as the general principle of it is retained. And I would also remark, that although my invention depends on the decomposition of the sulphuret of copper, and the formation of a soluble sulphate of the oxide of copper, I do not claim to be the discoverer of such decomposition, or of the formation of such soluble sulphate. I do not, therefore, claim as my invention the principle of decomposing sulphuret of copper ores, and forming a sulphate of copper, which has been long known; nor do I claim the obtaining a soluble sulphate of copper from copper ores; neither do I claim as my invention the precipitation of metallic copper from a sulphate solution; nor do I claim the furnace hereinbefore referred to, except so far as the same may be used for the purposes of my invention. But what I claim is, the mixing of the different ores of copper and iron pyrites in due proportion, according to the quantity of sulphur relatively with copper which they respectively contain, and adjusting them in such manner as, that those ores which hold sulphur in excess may compensate others which are wholly or partially deficient in sulphur, and in subjecting such mixture to a succession of roastings and lixiviations (the residuum after each roasting having the proportion of copper to sulphur adjusted as before), and thereby obtaining a solution of sulphate of copper, whence the copper is obtained by precipitation in a refined metallic state.

Enrolled February 7, 1846. Rep. Pat. Inv.

Specification of a Patent granted to WILLIAM BEDINGTON, *junior, of Birmingham, in the county of Warwick, for improvements in the Construction of Furnaces.*—Sealed July 10, 1844.

The invention consists of a mode of constructing furnaces so that the same may burn the fuel more advantageously, and the evolving of much dark, dense smoke from the chimneys prevented.



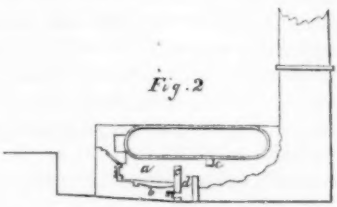


Figure 1, shows a section of a steam-boiler furnace arranged according to my invention.

Figure 2, shows a section of another arrangement of furnace, differing simply in the placing of the hanging bridge. *a*, is the furnace, which is of an ordinary construction, and may be varied in size, and also in arrangement, without departing from the invention. *b*, is the ash-pit, at the back of which, and behind the bridge, *c*, there is a chamber, *d*, into which a supply of atmospheric air is kept up, in order that the said air, rising upwards, may mix with the products passing from the furnace, and thus inflame them, there being suitable means for regulating the supply of air into the chamber, *d*, which may be accomplished by a valve, as shown at *s*, or a slide, or other convenient means, so that the person attending the fire may prevent too much air passing into the chamber, *d*, and yet that the supply shall be sufficient for causing the products coming from the furnace to be inflamed; but having once regulated the size of the opening, so that the furnace works well, I have not found it necessary afterwards to alter the opening for supplying of air.

I would here remark, that I am aware that various means have before been resorted to for supplying atmospheric air at the back of the bridges of furnaces, so as to cause the products passing beyond the bridges to be inflamed, and I therefore do not claim the introduction of atmospheric air at the backs of bridges, nor the making a chamber, *d*, behind the bridge of a furnace when separately considered; but *e*, is a hanging-bridge, by which the products, in their passage away, are caused to be deflected, and this aids the mixing of the products passing from the furnace with the atmospheric air rising out of the chamber, *d*. And though, with respect to the use of hanging-bridges, such as is shown at *e*, in Figures 1, and 2, I make no claim thereto in their separate form, as similar hanging-bridges have before been used, yet, combined with the use of a chamber, such as *d*, from which a supply of atmospheric air may be supplied to the passing products, in order to their being inflamed, I consider these hanging-bridges new.

In fig. 1, the hanging-bridge is placed over the chamber, *d*, whilst that in fig. 2, is shown just beyond the chamber, *d*, and I have introduced these two arrangements in order to sbow that the position of the hanging bridge may be varied. And it will be evident, that although I have only shown a steam-boiler furnace, other furnaces, for other purposes, will be readily made by a workman from the description herein given, the arranging chambers, *d*, at the back of the bridges *c*, and combining therewith the use of hanging-bridges, as herein explained.

Having thus described the nature of my invention, and the best means I am acquainted with for performing the same, I would have it understood, that what I claim, is the so constructing or arranging furnaces for steam-boilers, and other purposes, as to combine the use of chambers, *d*, and hanging-bridges, *e*, beyond the bridges, *c*, as herein described.

Enrolled January 10, 1845. Rep. Pat. Inv.

MECHANICS, PHYSICS, AND CHEMISTRY.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Description of the Iron Steamer "John Stevens."

WITH A PLATE.

The following detailed description of the splendid iron steamboat "John Stevens," which is now running between Philadelphia and Bristol, in connexion with the railroad line to New York, has been furnished to the Journal at our request. Com. Pub.

The Boat was built for the Camden and Amboy Railroad Company, and is the first boat, of the largest class, built in this country of iron. Her hull is made of the best quality of Pennsylvania plate and rib iron—the plate iron being ¼ inch thick and the rib iron of the angle form with this difference, from the common angle iron, that there is more iron on the top edge and less in the body, just the contrary to the common form. The ribs are placed two feet apart from centre to centre except immediately under the engine, where they are one foot apart, the size of the ribs, is 3½ by 2¾ inches, the weight 7½ lbs per lineal foot—she has four kelsons of ½ inch iron with angle iron riveted on top edge; they are three feet deep—two of which stand 12 feet apart, and are 164 feet long, the ends tapering for the length of 46 feet down to 12 inches in depth, upon which the boilers rest, which stand 41 feet 6 inches apart fore and aft—the other two kelsons are those upon which the engine rests, being 72 feet long and 3 feet deep, in the centre, for the distance of 24 feet, the balance being reduced to 12 inches in depth. These kelsons are all fastened to one another, and sides of boat, by cross kelsons, 3 feet deep and of a distance varying from 3 to 10 feet—she is also provided with a water-tight bulkhead of iron 27 feet from the bows which is a great safety to passen-

gers in case of the bows being stove in, which often happens, with great loss of life and property.

Being intended for a day boat and not having been fitted up with berths, her cabins and saloons are very airy, light, and roomy. The main cabin below is 60 feet long and 28 feet wide, with 8 windows on each side, 2 feet by 20 inches wide. The forward cabin below is 40 feet long and 28 feet wide, with 6 windows on each side, the two cabins being connected by a passage way 9 feet wide, and lighted by means of sky lights. The saloon on the main deck, is 60 feet long and 30 feet wide. The space enclosed on the main deck in front of the saloon, is 85 feet long and 31 feet wide. The upper saloon is 70 feet long and 30 feet wide. There is also, below, a cabin for emigrants, 25 feet long and 20 feet wide, and a forecastle for the crew. They are fitted up in the most complete manner with every regard paid to comfort as well as elegance. The cabins are furnished in white and gold and a large portion of the furniture is rosewood covered with plush.

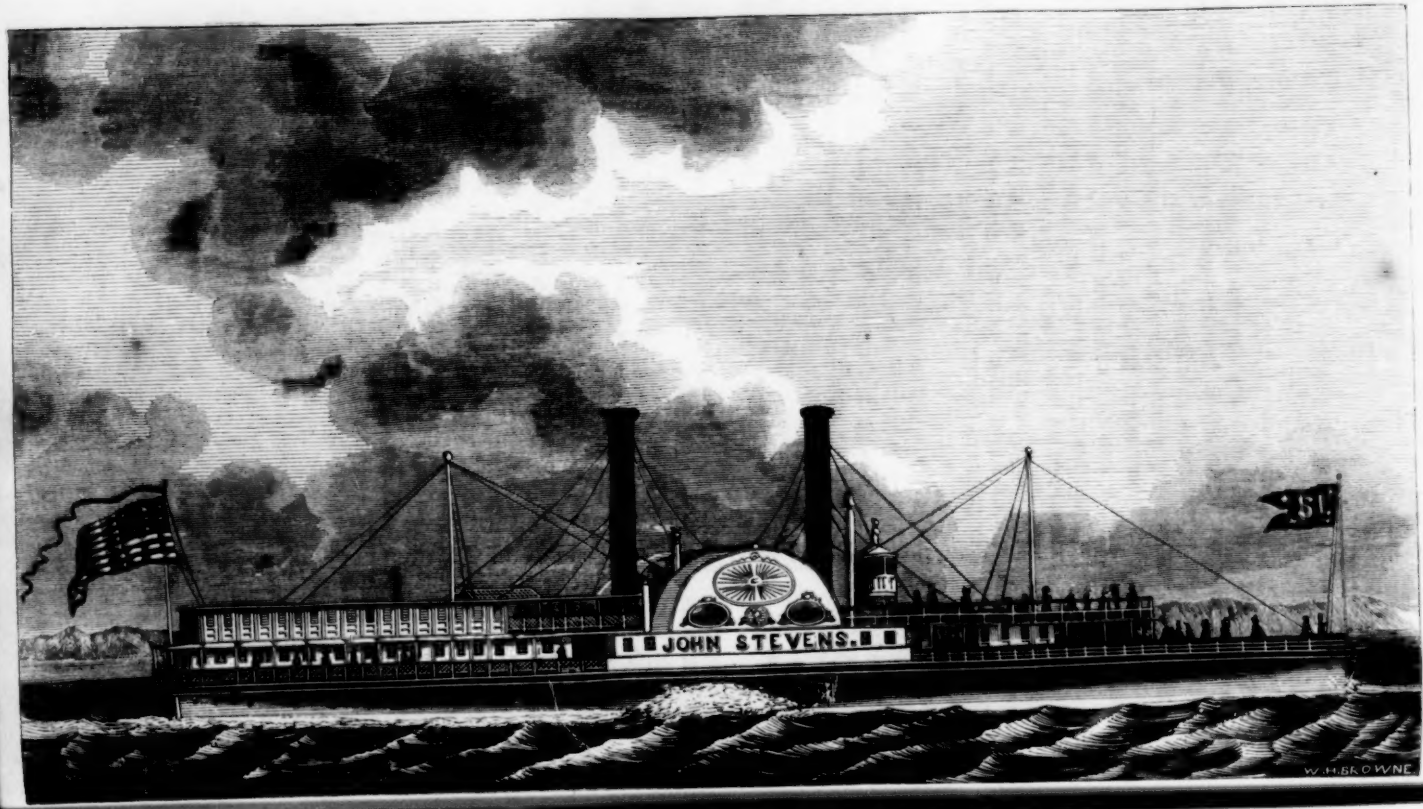
	ft.	in.
Length on deck,	245	
Breadth of beam,	31	
" over all,	65	
Depth of hold,	11	
Diameter of water wheels,	31	8
Face of " "	12	
Dip of " "	2	7
Tonnage,	800	tons.

Draught of water—completely ready for passengers with boilers filled and carrying, in iron tanks constructed for the purpose, and placed under the forward and after cabin floors, a sufficient quantity of fresh water, to feed the boilers for a four hours run, and also carrying fuel for the same length of time—5 feet. Her engine is of that kind, known as the steeple engine, improved by the addition of double connecting rods, with vibrating cross head, which passes through main cross head and works upon guides, by balance valves fitted with expansion gear to cut off the steam at from ¼ to ⅔ of the stroke of the piston, and also by an improvement in the air pump bucket, which has a circular double opening valve. The engine was made by Messrs. T. F. Secor & Co., of New York, and is a most beautiful and substantial piece of work, constructed entirely of iron with an accuracy and neatness of finish unsurpassed in this or any other country.

	ft.	in.
Diameter of cylinder,		75
Stroke of piston,	8	
Diameter of air pump,		31
Stroke of "	8	
Diameter of force pumps,		3½

Stroke of force pumps 8 feet, which are worked from the air pump cross head, one at each end—air pump cross head passes through one end of main cross head, and also works upon a set of guides at each end. Boilers of a tubular construction, placed fore and aft of engine being 15 feet long by 12 feet wide, each having 384 tubes, 12 feet

long and 1¾ inches bore. The furnace of each is 7 feet long by 11 feet 4 inches wide, the flame returning through the tubes, afafter having passed under the boiler. The boilers and coal boxes are below deck. The fires have an artificial draught from a circular fan 13 feet 6 inches in diameter, blowing into air-tight fire rooms, and worked by a small separate engine, of 16 inches cylinder and 14 inches stroke. The engine, when working with 30 lbs. of steam, cutting of at one half the stroke, and making 22 turns of the wheel, or 44 strokes of the piston, would, allowing 11 lbs. for vacuum in cylinder, and deducting 5 lbs. for friction, work to 1495 horse power. For further safety in case of leakage, she is provided with a bilge injection, of a capacity sufficient to supply the air pump, with as much water as it will lift, with the ordinary speed of the engine—also as a further security, against damage to the rudder, from ice or other floating substances, it is placed under the run of the vessel, the upper edge being 2 feet below the water line. Her speed is believed to be the greatest ever obtained by a steam boat, either in this or any other country. From trials continued for two days, made by running over a measured distance, of half a mile, made by placing ranges on Staten Island, near Fort Richmond, and directly opposite the ship channel, her time of going the distance, at different speeds, was accurately taken by two separate stop watches, and also with two revolving logs, which gave the speed exactly, as found by the stakes, agreeing within ¼ per cent of each other; and upon a further trial, in calm weather and deep water, it was found that the boat obtained a speed of 19 miles an hour, the engine at the time making 22 turns per minute, which is a greater speed than any authenticated record shows ever to have been performed. The posts for the ranges were set with a theodolite and still remain. The model of this boat was made by Robert L. Stevens, Esq., the draughts of the engine were also furnished by him. This being the sixth steam boat built by him at Hoboken, within the last 18 months, two of them being of the same size as this, and four built on an entirely different model, being built throughout with straight timbers. He also modeled the celebrated yacht Maria, belonging to the three brothers, Robert L., John C. and E. A. Stevens, which has been found to excel, in speed and accommodation anything of the class ever built—and we will farther mention that there are many improvements in the detail of the hull of the John Stevens, that have been introduced by Mr. R. L. Stevens, amongst which are the peculiar form of the rib iron, first introduced on her and since extensively used in England, and the arrangement of diagonal iron braces outside the hull above the water line. It may be mentioned as a proof of the accuracy with which the displacement of an iron boat can be calculated, that when completely finished, her draught of water agrees to ¼ of an inch with the estimate made before building. Her cost was a little upwards of $100,000.


JOHN STEVENS.
W. H. BROWNE

For the Journal of the Franklin Institute.

Fire-Proof Library.

PATERSON, SEPTEMBER 28, 1846.

To the Committee on Publications.

Gentlemen :—I can scarcely hope that so small a matter as my little fire proof building can interest you, but as you desired a description I proceed to comply with your request.

The building is intended to secure from fire a library which my wife inherited, and which, besides great pains, has cost a large sum of money. It is 24 feet by 18 feet outside, and 20 feet from foundation to the roof ceiling, giving 10 feet to each story, built entirely of brick, stone and iron, except the middle floor and 6 windows which are in front, and so much in advance of our other buildings as to be out of the reach of any danger. The ceilings are not yet plastered, as I want to see how the roof gets through the winter; but in every other respect the house is finished as I intended.

The walls are one foot through, and at four courses of brick above the ground, there is a strip of sheet lead placed all around the wall to prevent the attraction of moisture, so effectual is this remedy that the walls were perfectly dry two days after they were whitewashed.

The first floor is of stone 2½ inches thick by 4, and 6 feet square, the joints cemented with Roman cement.

The doors are two, which connect with a frame building and are of iron.

The second floor is 1¼ inch plank on 3 cast iron rafters, made in the form of a cross, each arm being 4 inches from the centre, and one inch thick. They were so cast as I intended to place them on a stone floor; but, apprehensive that a jar might break them, and endanger some one who might be underneath at the time, and not seeing any greater danger than there could be from the book cases surrounding and covering entirely the walls, I changed my purpose and put down plank.

The roof is of brick arches laid in Roman cement, plastered with the same outside, then washed with cement smoothly with a white washing brush. It is secure from fire, but I do not know how the frost may affect it, some tell me it will scale, others say it will answer very well for a number of years, if so, it is easily repaired and I shall be content. The arches are 2½ inches rise and 19 inches span, resting on cast iron beams alternating crosses as on the first floor, and T's 8 inches across the top and 4 inches in a vertical direction. The roof has an inclination of one foot in eighteen, and all the beams rest 7 inches on the walls. The walls are not seen, being covered with book cases and are therefore only white-washed. The cost of the whole is exactly as follows :—

39570	brick at $4	$158·2
20	barrels lime	20·0
40	loads sand	16·0
	Amount over,	$194

	Amount brought forward,	$194·28
6360	lbs. cast iron, 3½ cts.	222·60
½	barrel Roman cement	3·00
353	square feet stone	44·12
8	sills of stone	4·00
90	feet stone coping	12·50
	Sheet lead	11·00
	Mason work 18s. per 1000	90·00
	Whitewashing 2 days	2·00
	Stained glass windows	37·50
2	wrought iron doors	54·00
	Padlocks for same	2·50
5	windows	25·00
	Hinges and fastenings	10·00
	Wooden floor	10·50
	Carpenters laying	5·00
25	lbs. nails	1·00
	Window shutters and fastenings all trimmed	22·00
	Total cost	$751·00

If this be of any further use than merely to show how cheaply you can build in the country a thorough fire proof house, I shall be gratified to have it my power to present you a novelty.

Respectfully, JOHN TRAVERS.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

On using Steam expansively.

TO THE COMMITTEE ON PUBLICATIONS:—

Under a similar title, in the Journal for September, Mr. Erskine Hazard has promulgated very erroneous doctrines on various subjects, some of which I am desirous of correcting.

There is no lack of tables, showing the ratio of effect produced by steam at full stroke, and cut off at any part of it; in fact, that is shown by every table of hyperbolic logarithms; nothing more being necessary, than to find the logarithm corresponding with the number of times the space, occupied by the full steam, is contained in that occupied by the same when expanded: Thus, if the space into which the full steam is admitted be 1, and that into which it is expanded be 2, it is said to be cut off at ½ stroke, and, the effect or gain produced by the expansion, is represented by the hyperbolic logarithm of 2, viz. .6931, to which 1 must be added, making the total effect 1.6931, and this being divided by the space into which the steam is expanded, viz. 2, gives the average effect throughout the whole stroke of the piston, viz.: .8465 as shown by the table of Mr. H— at page 191. By this table also it appears, that the same quantity of steam is nearly 18 times as effective, when used expansively and cut off at $\frac{1}{100}$ part of the stroke, as when used at full stroke.

And now let me refer to page 194, where Mr. H. says, that "steam at 180 lbs. pressure, cut off at $\frac{1}{100}$ of the stroke, by the table, will give

an average pressure of 10 lbs. to the whole cylinder, and, by adding the vacuum and air pump, 10 lbs. more may readily be obtained."

Now omitting any remark, further than noting, en passant, the oddness of the expression contained in the latter part of the sentence, it would appear that Mr. H. supposes, that steam may be worked to almost any extent expansively without a condenser; let me tell him however that in this he is entirely mistaken, and that instead of "such an engine" giving "a power equal to two of Boulton and Watt's, of the same size, worked with atmospheric steam," it would rather require them to make it work at all; the pressure of the steam being already 5 lbs. under the atmosphere, according to his own statement. If the 180 lbs. is so much above the atmosphere, that makes but 195 lbs. altogether, and the average pressure throughout the whole stroke, would not even then be 11 lbs.—"adding the air pump."

Hence steam cannot be used to advantage with any great extent of expansion without a condenser, for, steam at 75 lbs. above the atmosphere, cut off at $\frac{1}{6}$ of the stroke, has not power enough at the end of it, to expel the eduction steam through the valve, and the same would occur with steam at 165 lbs. if cut off at $\frac{1}{10}$ of the stroke.

In short, either with or without a condenser, the steam must never be expanded so far as to be unable to overcome the resistance opposed to it, which, practically, must include the element of friction.

To illustrate this part of the subject, in a popular manner, with sufficient accuracy for practical use and easy of remembrance as an empirical rule where tables are not accessible, we may suppose 10 steam cylinders, all of the same capacity, and calling the whole 10 = 10, of course 1 = 1, we will use one of them only at full steam, calling the effect produced = 1: Now, all that can be made of that steam after it has produced that effect, is clear gain, let us therefore pass it into the second cylinder, and take the pressure at the centre as the average pressure throughout, which although incorrect is sufficient for our purpose, this pressure will be 1 at the commencement of its being let in, and .5 at the end, but the point at which we propose to take the pressure at, is, the centre between those two, where the steam has expanded to 1½ times, therefore $.666 = \frac{1}{1.5}$ is the gain effected by using the second cylinder; if we go on and use a third we have $.4 = \frac{1}{2.5}$ as the gain by using that only, making the whole gain = 1.066 = .666 + 4 and the whole effect 2.066 = 1 + .666. + 4, and so we may proceed, until we attain to those practical limits, beyond which it is a waste of power to proceed. When expanded 9 times, *i. e.* filling the 10 cylinders, the average pressure in the last is little more than $\frac{1}{10}$ that of the full steam, and the whole effect is 3.3026 by the table produced by 1 of full steam.

I will notice another error of Mr. H.—and I have done; it is, that "double pressure should contain a double quantity of water." He is led into this error by what he calls, but erroneously, a law of Dalton's, "that steam obeys the same law as the gases," &c., and no doubt

it does under the same circumstances: place steam, in point of temperature above, and of pressure below that of condensation, and out of contact with the liquid which forms it, and the law is correct. Boyle and M. de Sassure have proved that the absorption of water by gaseous bodies is directly as the pressure, so long as the temperature is the same, but when that varies, we must resort to a law discovered by Gay Lussac, Dulong and Petit, who have shown that gaseous bodies expand $\frac{1}{480}$ for each degree above 32° F. Now 100 cubic inches of gaseous vapor at 32° will weigh ·13716 grs. and its elasticity will be ·2 in. mercury, but if we increase the heat, we increase the elasticity also, and out of contact with water an increase of 180° of the former, will cause the latter to become ·275 in. $\left(= \cdot 2 \times 1\frac{180}{480}\right)$ at 212°. and as the elasticity and density of steam are in the same proportion so long as the temperature is the same (which is only re-stating in other words the law of Boyle and M. de Sassure) we have $14.9629 = \frac{30 \times \cdot 13716}{\cdot 275}$ or ·275 : 30 :: ·13716 : 14.9629 = the grs. of water in 100 cubic in. of steam at 212°, and 30 inches or 1 atmospheric pressure.

In calculating the following table, I have adopted the temperature, in accordance with the experiments of Dulong, Arago, and others of the Parisian Academy of Science, and the Rule 1. Multiply the pressure in inches of Mercury by 329.184 and divide by the temperature plus, 448° F., and the answer will be, the grains of water contained in 100 cubic inches of steam.

Temperature.	Pressure.		Weight of 100 In. of steam.
F.	in Atmospheres	in In. of Mercury	in Grs.
212°	1	30	14.9629
250.52	2	60	28.2755
275.18	3	90	40.9670
293.72	4	120	53.2574

Thus the increment of temperature, for each increasing atmosphere of pressure, decreases until at 24 At. only 3.78° additional temperature will be necessary to reduce the pressure to 25 At.

As an approximate rule, to find the temperature at which the pressure of steam will be doubled:

Rule 2. Multiply the temperature by 1.179 and the answer is the temperature at which the pressure will be doubled, nearly.

I must now close this long article, as I have already extended it beyond the limits I had fixed upon.

Yours respectfully,

THOMAS PROSSER, C. E.

New York, September 30th, 1846.

Manufacture of Large Achromatic Lenses.

Translated from the *Comptes Rendus* for the Journal of the Franklin Institute.

By the following extract from a recent French Journal, it will be perceived, that the present highly improved state of the glass manufacture in France, bids fair to enable the construction hereafter, without difficulty or excessive cost, of those large achromatic lenses, which, though a great desideratum in astronomy, have hitherto foiled the ablest opticians. COM. PUB.

Mr. Arago read (before the academy), some passages from a letter which Mr. Bontemps wrote to him, and by which this very able director of the glass works of Choisy-le-Roi offers to the bureau of longitudes, the masses of glass necessary for the projected execution of the large achromatic telescopes, for a price almost incredibly small. The following are the extracts:

"A disk of flint glass for a lens of 55 centimetres* aperture, weighs about 40 kilogrammes; I would estimate these 40 kilogrammes at 10 francs per kilogramme, this is nearly the price at which I sell the flint glass in plates for lenses from 3 to 7 centimetres aperture; these 40 kilogrammes at 10 francs, make . 400 francs.
The expense of softening† will be about . 150 "

I will furnish, then, this disk of 55 centimetres, for 550 "

"A disk of the same kind has heretofore been worth 40,000 francs, when the fabrication was still in its infancy. We have sold a disk of 32 centimetres for 3,000 francs; and a disk of 38 centimetres for 5,000 francs.

The disk of crown glass, of 55 centimetres, will weigh about 25 kilogrammes, at 10 francs, . 250 francs
The softening will cost about 200 "

Total, 450 "

"The disk of flint glass, and the disk of crown glass, for the lenses of 55 centimetres aperture will cost, then, 1000 francs.

"A disk of flint glass of 1 metre‡ in diameter, will weigh about 150 kilogrammes, this will be, at the price of 10 francs 1500 francs
The cost of softening will be about 1000 "

Total, 2500 "

"The disk of crown glass will be about the same price.

"To construct a disk of this kind, I shall be obliged to make a furnace, and larger crucibles, but the operation having in fact the same degree of certainty, the cost of this furnace will be covered by the current sale of flint and crown glass.

"It should be indispensable, when we desire to make a lens of large dimensions, not to manufacture one disk solely; I will therefore place at the disposal of the bureau of longitudes, several disks of the diameter of the object glass which we desire to construct, and only that one which shall be acknowledged to be the best, shall be paid for to me; the remainder shall enter into the common consumption for optical purposes."

*21 2-3 inches English measure nearly. †And moulding.—[Trans.
‡ 39.371 do. do. do. do.

Extract from the "Comptes Rendus" of the 13th May, 1844.

"Mr. Arago submitted to the academy, a project relative to the execution of a large astronomical telescope, a project which was conceived in consequence of the recent progress made by the French glassmakers, in the manufacture of flint and crown glass. The new instrument will have dimensions greatly superior to those of the telescopes which have been heretofore made—will require, on the part of the artist who shall be charged with its execution, the employment of new methods, which would doubtless be a subject of long and expensive experiments for him, if he were not directed by the advice of persons skilful in such matters. Mr. Arago proposed then to the academy, to form a committee immediately, to be taken from their body, to give instruction on this subject—Messrs. Biot, Arago, Gambey, Regnault, and Babinet, were appointed members of the committee."

TRANSLATED FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Description of the Process of Manufacturing Flint Glass and Crown Glass. By G. Bontemps, Director of the Glass-house of Choisy-le-Roi.

On the 27th January, 1840, I read, at the Academy of Sciences, a memoir on the manufacture of flint glass and crown glass; in that memoir, I gave a historical sketch of the attempts made, at different times, to produce flint-glass and crown glass suitable for optical purposes. P. L. Guinand, senior, of Brennets, in Switzerland, was the first who discovered a special process for that manufacture. After his death, I purchased from his son, the secret of the manufacture; I succeeded, in 1828, in manufacturing flint glass suitable for optical purposes, of which I presented specimens of a large size to the Academy of Sciences, in October, 1828. The most important part of the problem was solved, but I was also anxious to succeed in manufacturing crown glass that might be substituted in place of cast-glass, in the construction of the finer kinds of optical instruments; in my attempts, I met with very great difficulties, which I at length surmounted, and have manufactured crown glass equal in quality to flint glass; that is to say, free from striæ, from bubbles, from threads, and which does not attract moisture. After having made known all the *phases* of this manufacture, the details of all the difficulties which had to be overcome, I now propose to give the description of the process.

The invention of M. Guinand, Sr., consists in working and stirring the material while in a state of fusion, by means of a tool made of the same material as the crucible or glass-pot. He made a hollow cylinder of fire-clay of the same height as the crucible, closed at its lower extremity, open above, with a flat ledge all round of several centimetres in width. Having heated this cylinder red-hot, he placed it in the melted glass, then, by means of a long bar of iron, bent to a right angle at a distance of some centimetres from its extremity, which

he introduced into the cylinder of fire-clay, he worked and stirred the glass, by giving the bar a horizontal rotary motion.

For the manufacture of flint glass, and of crown glass, I have adopted a circular furnace, in the centre of which I place the crucible, or glass-pot, all the parts of which are exposed to the same temperature; and I have adopted the use of covered crucibles, because with crucibles of this form there is no danger of the glass being spoiled by particles of the fuel, or by drops, or tears *(larmes)* from the crown or arch of the furnace.

The success of the operation depends very much on the form and proportions of the furnace and crucible.

I will now give the details of a melting of flint glass, and of a melting of crown glass.

The figures represent the furnace, the crucible, the cylinder of fire-clay, the bent iron bar and its support.

Flint glass, of the usual density, similar to that used for table-sets, decanters, &c., is composed, ordinarily, of 300 parts of sand, of 200 parts of deutoxide of lead, and 100 parts of sub-carbonate of potash.

The density of this flint glass is from 3·1 to3·2.

The following composition, expressed in kilogrammes, gives the quantity necessary to fill the crucible: sand, 100 kil.; deutoxide of lead, 100 kil.; sub-carbonate of potash, 30 kil.

This composition gives a very white flint glass, of a density of from 3·5 to 3·6, and which is perfectly suitable for opticians.

It is scarcely requisite to insist on the necessity of purity in the raw materials, and the cleanliness to be observed in mixing them. It is not necessary to use either lime or arsenic, the only effect of which would be to diminish the whiteness of the material.

Details of the Operation for Flint Glass.—The crucible is to be heated in a special furnace kept for the purpose, and when at a white heat, it is to be introduced, in the usual manner, into the melting furnace, which has been brought to the same temperature; this operation cools the furnace and the crucible; the furnace must be re-heated in order to bring it to the highest possible temperature before introducing the materials *(enfourner;)* this takes about three hours; the throat of the crucible, which has been closed with two stoppers to prevent the entrance of smoke, is then opened, and about 10 kilogrammes introduced; one hour after, about 20 kilogrammes more, then, two hours after, 40 kilogrammes; each time the crucible must be re-closed with the greatest care, and nothing must be put in until the coal on the grate ceases to give out any smoke. At the end of from eight to ten hours, the whole of the composition will have been introduced; the crucible is left without being opened for about four hours; then the stoppers are removed for the purpose of introducing the cylinder of fire-clay, which has been heated separately to a white heat in the same furnace, and kept at that temperature until placed in the crucible; care is to be taken to keep it perfectly clean and free from ashes. At this period, the flint glass is melted, but it still contains bubbles; nevertheless, the bent iron bar is introduced into the cylinder, and the first stirring is given, which serves to coat the cylinder with glass,

(enverrer,) and to effect a more intimate mixture; at the end of about three minutes, the iron bar is white hot; it is taken out, and the ledge of the cylinder is placed on the edge of the crucible; this cylinder, being specifically lighter than the glass, floats slightly inclined, because its upper ledge is outside of the glass. The two stoppers are so replaced as not to push the ledge of the cylinder into the glass, and the stirring up of the fire *(tisage)* is recommenced. Five hours afterwards, a fresh stirring up with a single iron bar takes place, the glass is already well refined, and then from hour to hour there is a stirring, each time with a single iron bar; great care being taken that at each stirring there shall be no smoke in the furnace, and that the lower doors of the furnace are closed. After having thus used six iron bars, from 25 to 30 centimetres in thickness of coal is thrown on the grate, which forms a mass quickly reduced to coke, and which allows the furnace to cool, without exposing the grate uncovered. The various openings of the furnace are unclosed, the whole furnace and the crucible thus gradually and slowly cool; this operation tends to cause the bubbles which are not yet disengaged to rise to the surface. At the end of two hours this operation is finished, the furnace is again brought to the melting heat; after five hours of the highest temperature, the glass has resumed its greatest fluidity, the bubbles have disappeared, the grates are completely closed below, and the great *(brassage)* stirring commences, that is to say, as soon as one iron bar is hot, another is substituted for it, and so on, for about two hours. At the end of this time the material has acquired a certain consistence, the stirring is not executed without difficulty; then the last iron bar is taken out, the cylinder is removed from the crucible, which is very carefully closed, as well as the chimnies and openings, except a small hole of 2 centimetres, to permit the escape of the gas, which may have remained in the fuel. When the disengagement of gas ceases, the furnace is entirely closed, and it is suffered to cool, which takes about eight days; the door of the furnace is then removed, the crucible, with its contents, taken out, usually in a single mass, except some fragments which become detached round it; the only object now is to make use of this mass and these fragments, the mode of doing which we will explain directly, after having given the details of the operation for crown glass, which, as may be supposed, has a great analogy with the preceding.

Manufacture of Crown Glass.—After many experiments, I have found the following composition to be the best: white sand, 120 kil.; sub-carbonate of potash, 35 kil.; sub-carbonate of soda, 20 kil.; chalk, 15 kil.; arsenic, 1 kil.

The crucible having been placed in the furnace, as for flint glass, the introduction of all the materials is to be completed in about eight hours, four or five hours after which the cylinder is to be introduced, and the first stirring takes place; then, every two hours, a stirring with a single iron bar; six are to be executed in this way; the furnace is to cool very slowly for two hours, after which it is to be reheated for seven hours, this glass regaining its heat with much more difficulty than flint glass; the great stirring *(brassage)* then takes place,

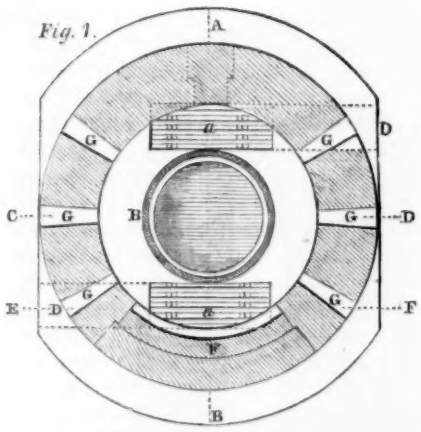
which lasts about an hour and a quarter; the crucible, the chimnies, and the openings are to be closed, as for flint glass, and the whole is left to cool. Very commonly, as with flint glass, a mass and several fragments are obtained.

Parallel faces are made on the sides of the mass, whether of flint glass or crown glass, in order to examine the interior, and to see how it should be divided, for it is never free from striæ, which are usually found collected in one portion of it. After this examination, it is sawed into parallel slices, or transverse sections, in accordance with the observations made. Faces are also polished on the fragments, for the purpose of examining them, and disks are made of them in accordance with their weight; for this purpose, they are first heated in a furnace and then introduced into a muffle, where only the heat necessary to enable us to mould them is given. If the fragment is irregular, it is partially rounded by the nippers, and then, with other nippers, it is placed in a mould, under a lever press, which gives it the exact form of the mould, after which it is taken out with the nippers and carried to the annealing arch.

Explanation of the Plate.

Fig. 1. Horizontal projection of the furnace and crucible.

Fig. 2. Section along the line E F, fig. 1; that is to say, along the flue.



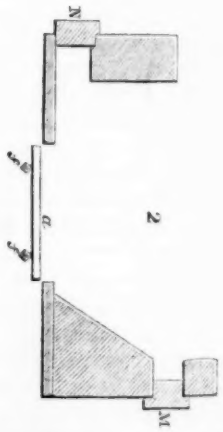
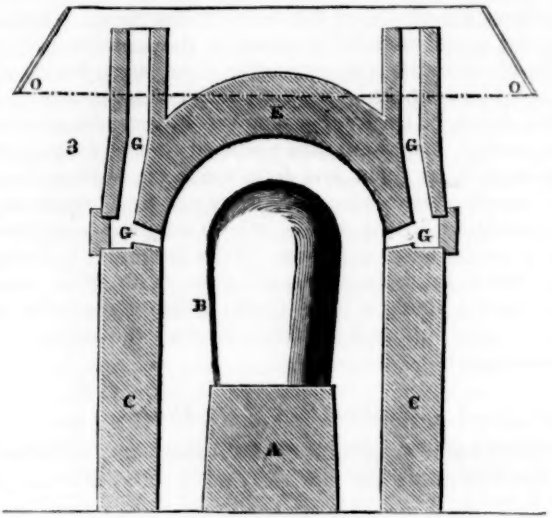


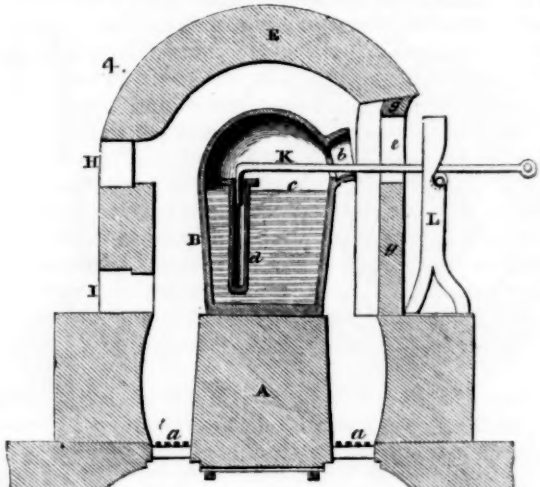
Fig. 3. Vertical section along the line C D of the plan.

Fig. 4. Vertical section along the line A B of the plan.

The same letters mark the same objects in all the figures. A, foundation or support of the covered crucible B. C, C, walls of the furnace. D, D, openings through which coal is thrown on the grate. E, arch or crown of the furnace. F, door or opening through which the crucible B is introduced and taken out; there is a small opening in this. G, G, G, six chimnies. H, an opening. I, hole to facilitate the placing the crucible on its support. K, bent iron bar, for working the

fire-clay cylinder. L, support, with a roller across, on which the bar K is supported. M, hole, with a stopper, through which the coal is thrown. N, hole, with a stopper, through which the grate is cleared.





O, hood of sheet iron, under which the chimnies terminate. *a*, *a*, grate of the furnace. *b*, throat of the crucible. *c*, level of the melted glass. *d*, fire-clay cylinder for stirring. *e*, opening. *f*, *f*, bars supporting the grate. *g*, door of the opening *e*.

On the Diurnal Changes of the Aqueous portion of the Atmosphere, and their Effects on the Barometer. *By* Thomas Hopkins, Esq.

It is admitted by meteorologists, that the various quantities of aqueous vapor which exist in the atmosphere during the different hours of the day, contribute to the production of the variable atmospheric pressure, and the semi-diurnal fluctuations of the barometer. The vapor is, at a certain hour in the morning, at its minimum quantity, from which it increases during the day up to its maximum; after that it declines, and its variable pressure is exerted on the mercury of the barometer, and affects the height of the column. This takes place in a less or greater degree in all latitudes, though to the greatest extent near the equator.

The quantity of vapor existing in the atmosphere in each hour of the day is ascertained from the dew-point, or point of condensation; it having been found that each particular quantity of vapor diffused through the air has its separate dew-point. The dew-point is therefore taken as the measure of the quantity of aqueous matter existing in the atmosphere, and of the vapor pressure at every period of time. This pressure, thus ascertained, being deducted from the whole atmospheric pressure, furnishes the amount of the gaseous pressure, as given in our meteorological registers and tables.

But, is the dew-point a correct measure of the quantity of aqueous matter that passes into and remains in the atmosphere during the different times of the day? On the answer to this question it depends whether the hourly vapor and gaseous pressures on the barometer are, or are not, correctly given in our registers. If the dew-point be a true measure, then the pressure arising from aqueous matter may be taken to be such as is stated in those registers, and so far all the reasonings respecting the causes of the diurnal fluctuations of the barometer may be correct; but if the dew-point is a fallacious measure of that pressure, then the alleged facts may be unfounded, and the conclusions drawn from them erroneous.

There is reason to believe that in certain parts of the world, and for considerable periods of time, the dew-point may be a correct indicator of the pressure of aqueous matter, but in other parts it may not; and in order that we may trace this difference, in different times and places, we will inquire what are the relative quantities of vapor that hourly pass into the atmosphere, in some of those parts from which we have been furnished with accounts, and endeavor to learn whether those quantities are such to as to accord with the dew-points.

Kaemtz, a German meteorologist, in his Course of Meteorology, has furnished tables of the hourly vapor pressure in different places, deduced, in the usual way, from the dew-point, and among them of that which is found to be the mean of the year at Appenrade, in Denmark, from seven in the morning to eleven in the evening. At seven, the pressure, in French measure, is 8 millimetres ·119, from which it

increases until one in the afternoon, when it reaches 9·511. From this time it diminishes, and at 11 P.M. is only 7·863.

The same writer has given the vapor pressure on the coasts of the Baltic, at Trapstow, near the Rya, for the months of July and August. It appears that in those parts the minimum pressure for July is 10·05 at two o'clock in the morning, and the maximum is 11·41 at two o'clock in the afternoon. For August, the minimum is 11·18 at three o'clock in the morning; and there are two risings, the first until ten o'clock, when it is at 12·05: from this time it falls till two, and then suddenly rises until three o'clock, from which time it falls for the rest of the day. From these statements, we find that there is, on the coasts of the Baltic, particularly in August, in the middle of the day, a material departure from a single rise and a single fall in the vapor pressure.

There are also tables for Zurich, and other places in its neighborhood. At Zurich, in the month of June, the minimum pressure is 10·56 at 4 A.M., from which hour it rises until 8 A.M. After this it falls a little, and irregularly fluctuates until 8 P. M., when it reaches 11·34, having fluctuated greatly during twelve hours, namely, from 8 A.M. to 8 P.M., and ranged 0·78.

In September, at the same place, the minimum was at 5 A.M., and there were two risings, with an intervening fall. The first rise was up to 12 o'clock,—four hours later than the first in June; and the advance above the minimum was 1·73, making a greater range than that of June by 0·95. Here, too, the disturbance in the middle of the day is very palpable. These parts of the world are at comparatively low levels,—the first named being near the sea, and the last (at Zurich) an inland situation, which, though considerably above the sea, is not on a mountain.

When these observations were made at Zurich, in the month of June, others were made on the adjoining mountain, called the Righi, 1402 metres above the Lake of Zurich. On the Righi, the minimum pressure was at 5 A.M., an hour later than that on the plain, being then 6·27, from which it rose until noon, and reached 7·54, making a range of 1·27. From this hour, the pressure declined until five the next morning.

On the Faulhorn, a mountain in the same locality, but higher than the Righi by 870 metres, observations were made in September, at the same time as others were made at Zurich; and on the mountain, the minimum pressure was 3·40, and occurred at 6 A.M., an hour later than at Zurich. From this time it rose until 3 in the afternoon, when it reached 5·07, making the range in the day so much as 1·67. It is thus shown that the range of vapor pressure was greatest, not where the temperature was the most raised, and where evaporation must have been the greatest, but in the latest and coolest month, and on the highest mountain! And in September, the pressure increased to the latest period of the day, not near the surface, the source of evaporation, but on the high mountain. These irregularities show that some cause was in operation, which determined the vapor that had been produced by evaporation from the surface of the earth in the warm

and comparatively dry month of June, to continue increasing at the low level up to eight in the evening, but to accumulate only to a moderate extent, whilst on the mountain it accumulated to a much greater extent, but not later than until noon. In the cooler month of September, however, the vapor accumulated to about an equal extent, and about the same times,on the low level and on the high mountain, presenting a great difference between the action of the vapor in June and in September. The absolute pressure of the vapor, it will be recollected, is greater in the lower than in the higher strata; but the increase of that pressure is greater in the higher part in the dry and warm month of June, while it is only equal in the moist and cool month of September, showing that it was not merely expansion and diffusion of the vapor produced by evaporation that were in operation, but that some other cause was at work, which made the vapor accumulate on the mountain more than on the plain in June, but not in September.

In high latitudes, the pressure of the vapor is the least in winter, and the most in summer. In Halle, in Prussian Saxony, for instance, it is 4·509 in January, and in July 11·626, almost three times the amount; and the same kind of difference between winter and summer is found in other northern parts. Generally it may be said to be the least in winter and in cold climates, and the most in summer and in warm climates.

When the dew-point, contiguous to the surface of the earth, is the nearest to the temperature, which is, say, at four or five in the morning, both the temperature and the dew-point are the lowest. From this time the temperature rises more than the dew-point, until the former reaches the highest point for the day. There is consequently in the lower part of the atmosphere an increasing difference occurring between the temperature and the dew-point up to the time of the highest temperature. But this does not take place in the same degree in the higher strata, as in them the dew-point progressively approximates to the temperature, until at some height the two become the same. In the forenoon, therefore, the lower air has its temperature removed progressively further from the dew-point, but when it ascends, it approaches the dew-point of the higher strata, until at last, at some height, condensation takes place, and cloud is formed. When this occurs, the vapor that is in the air below the cloud, being partially relieved from incumbent vapor pressure, ascends more freely from the lower to the higher regions, where the cloud is forming. Thus it is the rise of temperature near the surface that increases evaporation and raises the dew-point, and the vapor produced by this evaporation expands and forces its way upwards by its own laws of expansion and diffusion. But in ascending it cools by expansion 1° for, say, every 500 yards, whilst it has to pass through the gaseous atmosphere, a medium which is made colder by its own law of cooling, 5° for every 500 yards of elevation; therefore, as the vapor ascends, it must at some height reach a temperature low enough to condense a part of it and form cloud. On the formation of the cloud taking place, a part of the vapor that is in the atmosphere is converted into globules of

liquid, (water,) and the pressure of this condensed vapor on that immediately below it, nearly ceases: for these globules of water, unlike the vapor from which they have been formed, do not rest upon or float in the *vapor* atmosphere alone, but also on the *gaseous* portion of the atmosphere, which, from its superior quantity and density, will sustain the greater part of the weight of this floating water. The lower vapor, relieved from a portion of that which previously pressed on it, expands upwards more rapidly, and ascends sometimes so freely as to prevent such an accumulation as shall further raise the dew-point, although evaporation continues active below. Indeed the pressure from above may be so far removed by cloud formation, and the ascent of the vapor be rendered so free and rapid, as to lower the dew-point, as took place both at Zurich and on the coast of the Baltic. The processes which have been here described may be traced by attending at the same time to the dew-point and the heights of the ordinary and the wet-bulb thermometers. These are exhibited in the Plymouth registers and diagrams, presented to the British Association by Mr. S. Harris.

By reference to these it may be seen that at Plymouth the difference between the dry and wet-bulb thermometers is, at five in the morning, say about 1° of Fahrenheit. This difference increases until one in the afternoon, when it is, say, 4°; evaporation must therefore have gone on with increasing activity during this time; and at three o'clock, that is two hours after the time of highest temperature, the difference between the two thermometers is greater than it was at eleven o'clock, two hours before the highest temperature! Evaporation must therefore have been more energetic, and must have continued to throw into the atmosphere more vapor from eleven to three than it had done four hours earlier! Now, if increase of vapor pressure always accompanied increase of vapor, the increase of pressure at Plymouth must have continued up to three o'clock! If, however, we look at the curve or line of the dew-point, which represents vapor pressure in the diagram, we find that it did not rise after eleven o'clock, but continued stationary from that hour until 4 P.M.! It is therefore apparent, that at Plymouth the quantity of vapor which by evaporation passed into the atmosphere in the middle of the day, to add to the general atmospheric pressure, in some form, was not indicated by the dew-point. And analogy authorizes us to infer, that in other parts of the world, the state of the dew-point during the same portion of the day does not express the quantity of vapor that has passed into the atmosphere, and which must have added to its general pressure on the barometer.

In the Toronto registers, reported to the British Association at York in 1844, by Col. Sabine, the state of the wet-bulb thermometer is not given. But we may assume that, if it had been given, it would have shown the same features as those we have in the Plymouth registers and diagrams. In this report, it is, however, stated that Mr. Caldecott has transmitted to England five years of hourly observations with the wet and dry-bulb thermometers at Trevandrum, near Cape Comorin, where a large quantity of vapor generally exists in the atmosphere. It appears from these accounts that the minimum

and maximum pressures of the atmospheric vapor are there found to occur within three hours of each other,—the minimum coinciding with the coldest hour, 6 A.M., and the maximum occurring so early as at nine in the forenoon! Now, it is very desirable that it should be ascertained whether evaporation did or did not go on freely from the wet-bulb thermometer from six in the morning, not only until nine in the morning, but until two in the afternoon, the time of the highest temperature. Although the dew-point ceased to rise at nine, it is to be presumed, reasoning from analogy, that energetic evaporation continued through the middle of the day, and it probably was, (as at Plymouth,) more active between nine and two in the day, than it had been in any part of the time between six and nine in the morning. And the vapor which was thus produced at Trevandrum between nine and two, or still later in the day, may have ascended and formed cloud, which cloud must have added to the general weight of the atmosphere. Had we accounts of the state of the wet and dry-bulb thermometers, and of the dew-points at different heights, there is little room to doubt that we might trace the ascent of the vapor at Trevandrum until we found it collected and floating in the atmosphere as a cloud, and in that form adding to the general weight of the atmosphere.

Col. Sabine says that the maximum of vapor pressure occurring at Trevandrum at 9 A.M., may be a consequence of the sea-breeze blowing at that time. I have, however, shown that the daily sea-breeze is itself produced by the diurnal cloud formation; the sea-breeze is only another effect arising from the same cause. The sea-breeze blows towards the part, because the atmosphere has there been made lighter than in adjoining parts by the heating power of condensing vapor. The wind, too, that comes from the sea, particularly in the fine season, when the diurnal disturbance of the barometer is the greatest, comes more fully loaded with vapor after nine o'clock than was the air over the land before that time, and ought to increase the vapor pressure after that hour, instead of stopping the increase. If all the vapor that arose had to come from the same land surface of the locality, it might be supposed that evaporation could not continue to supply an adequate quantity to raise the dew-point after nine; but when the sea-breeze sets in, a current of air comes from an extensive sea surface, and brings with it the vapor which had been evaporated from that surface, not only up to nine o'clock, but until ten, twelve, or two o'clock, or still later: the tendency of the sea-breeze is therefore not to reduce, but to increase the supply of vapor. It may also be remarked, that whilst the maximum of vapor pressure is said to occur at Trevandrum at nine o'clock, the sea-breeze does not set in at Bombay until about eleven or half-past eleven. Supposing both these places affected alike by the sea-breeze, the cause of the stoppage of increase of vapor pressure, whatever that cause may be, must have been in operation two hours before the sea-breeze commenced blowing.

Formation of cloud is a cause sufficiently powerful in its operation to prevent the dew-point rising at Trevandrum after 9 A. M., as the

vapor produced after that hour may be equal only to that which is consumed in cloud formation; and we are authorized to conclude that it is to that formation we are to attribute the stoppage of the dew-point at Plymouth at eleven, and at Trevandrum at nine o'clock, instead of having it rising with the temperature during the hottest portion of the day in both places. And in the more northern or drier climates, if we do not always trace the same stoppage, it is to be attributed to the absence of daily cloud formation. In a very dry and cold climate, there is not in the course of the day sufficient water evaporated to produce a daily thick cloud, and therefore small vapor pressure goes on increasing with the temperature up to the hottest period. Under these circumstances, the vapor pressure, when exhibited in a diagram, forms a regular curve, having one rise and one fall in the twenty-four hours; but where much vapor exists, and much more is produced daily, the dew-point does not at all times indicate the pressure which results from evaporation, because the rise of the dew point is stopped at certain periods, not by a cessation of the production of vapor, but through its ascent in the atmosphere and conversion into a floating cloud. Boiling water in the open air does not rise above 212°, yet heat continues to pass into it from the fire that is under the water. The reason that the temperature of the water does not rise higher is, that as much heat passes from the water into the air as from the fire into the water. In like manner, evaporation of water may continue to throw vapor into the air without the quantity in the air increasing, because condensation may convert vapor into water as fast as evaporation furnishes it. But neither the fire nor the vapor is annihilated,—the fire passes into the atmosphere and the vapor becomes cloud, and we may trace both of them in their new state of existence, and mark the effects they produce.

Taking the period of a year, in all places the average daily march of the temperature shows a single rise from about six in the morning till one or two in the day; and evaporation, as shown by the wet-bulb thermometer, increases with the rise of temperature. If the whole weight of the vapor thus produced were to be registered and exhibited in the form of a curve, that curve would be the same in form as the curve of temperature, having one rise and one fall. But in the actual curve or line of the dew-point there is frequently found to be a fall where there should be a rise. At Zurich, and near the Baltic, the departure from the regular curve is considerable; in Plymouth, the line is level from eleven to four; and in Trevandrum, if a curve were formed, the line would cease to rise at nine o'clock, five hours before the hottest period! At Trevandrum the minimum and maximum of the dew-point occurred within three hours, whilst on the Faulhorn they were nine hours asunder; at Zurich, in June, they were sixteen hours asunder; and in other parts similar anomalies occur. These irregularities may be accounted for on the supposition that condensation of vapor produces them, because that process is very irregular in its action; but if this supposition is admitted to be true, it will follow that the dew-point is not a correct measure of the daily addition that is made to the weight of the atmosphere in the middle of the day by

the vapor that has been thrown into it, and therefore it does not present the means of ascertaining the separate gaseous pressure. For the same operation that keeps down the dew-point in the middle of the day, creates cloud that floats in and rests upon the whole mass of the atmosphere; and the gaseous portion of that atmosphere must then press on the surface of the earth, not only with its own weight, but with the additional weight of nearly the whole of the cloud that is then floating in it. And if the curve of gaseous pressure, as commonly given, does not show a rise resulting from this additional pressure, it is because the whole atmosphere is at the same time made lighter by the heat which has been liberated by condensation of vapor.

Lond., Ed. & Dub. Philos. Mag.

On the Proper Coal for Smelting Sulphuretted Lead and Silver Ores.

Sir,—Being in the neighborhood of a lead mine some short time ago, I was in company with a gentleman who gave a lecture on *galena*—the produce of the mine. I cannot give his ideas clothed in the eloquence of the lecture; but I feel my memory is not far erring in reporting the matter of the introductory part as follows. It amused me for its truth and quaintness. He commenced (taking from the table a lump of *lead-looking* galena) thus—"Gentlemen, I take into my hand what to all must appear to be a lump of lead: indeed, what else can it be? I have procured such before, and have experimented on it, and you shall hear the result of my experience. I placed it, in order to cast the same into a mould, over my fire, in a melting ladle, and patiently worked away, for a very considerable time, with the large kitchen bellows to make it flow; but to my great disappointment, I could not melt it. I considered the fire to have been a bad fire, and proceeded to make it anew; and a large and powerful fire I finally obtained; but yet my lead would not melt. What can the cause have been? I procured a small furnace, and succeeded in raising an intense heat; but even at this temperature my metal would not melt. At length I tested it in the powerful heat of a well-constructed reverberatory furnace; and, gentlemen, judge of my surprise—instead of melting into metal, as I expected, it ran into a dark-looking, dense mass of matter, no more like to lead than I am to a *brass candlestick.* As to temperature, I experimented on this in every possible degree, I verily believe; but, although I could soften it, I could not change it from its black, slag-looking state, and I never could succeed in separating any metal from it. Gentlemen (continued the lecturer with much energy), what is my enemy? Surely some evil thing mars my constant endeavors? What can it be? What is its nature, its habits, its wants? Can it be the vexatious interference of the Father of all Evil opposing me bodily? or has he here instead his *earthy representative*, SULPHUR? Indeed, it must be so. Gentlemen, how he *hug'd* his prey! How to cast out this *evil one* demands the very first attention. Fire won't do it: *no—he is too used to fire.* All the heat of

ten thousand times ten thousand of Nebuchadnezzar's burning fiery furnaces won't move him. He claws too tightly to be moved by fire; indeed; gentlemen, the greater the heat, the greater seemed the consolidation of the union of this evil one with my wished-for metal."

The effects of heat on sulphurous ores, as here described by the lecturer, certainly are correct. Heat alone, even the most intense, will not separate sulphur from lead, when in a close vessel; it will rather do mischief to your sulphurous ores, and render them less easily treated beneficially afterwards. These ores require to be carefully treated at a proper heat. But more than *mere heat* is necessary. *Oxygen gas* (atmospheric air) is also absolutely essential to effect the separation of the sulphur from the ore. Cold atmospheric air, admitted through your furnace doors, would in smelting be injurious. The oxygen of the air must be admitted of the same temperature as your furnace. The air must pass freely through the fire-chambers of your furnaces, and become of like temperature. A coal, therefore, to allow of this free passage of air, must possess peculiar properties, as hereafter explained. The coal necessary for treating such sulphurous ores as silvery galena must have these peculiar properties. It should be a coal highly charged with inflammable gas (hydrogen). It should, notwithstanding, have the property of a good coke. It should have high heating powers,—and should have the property also of *keeping itself light* in bulk during burning—that is, it must *not bind or cake*, like the best Newcastle household coals do. Every lump should keep for a long time (while even at a white heat,) its original form, like coke does—and thus keep a very *hollow* fire. Now, the effect of this hollow fire, and the lumps of coal being all independent of each other, like cannon balls in a tub, is, as you will readily understand, that, with the immense draft of the stack, a large quantity of oxygen is, with great facility, admitted between the red-hot independent lumps of coal, and heating the air to its own temperature,—and thus presenting itself in a very favorable state to act on our enemy, the sulphur. There are, of course, many difficult and interesting processes, besides the admission of air, to be performed before you can get the metal to flow; but we are now confined to the subject of coal only. In separating sulphur, *atmospheric air* at *high* temperatures is necessary,—and the way to obtain this is using a coal with the properties before mentioned; and even with this coal, the fire must be constantly attended to.

When the furnace is well heated, the fire must be lifted up to open it, as it were—and this more or less, according to circumstances—to allow a due quantity of air to pass through the burning mass. There requires much experience and judgment in managing this part of the process. The good smelter, indeed, should almost live in the ash-pit. He should put a woolen cap over his head and shoulders, and be ever keeping his eye on his fire, keeping it *duly* hollow (for it wants more or less of this according to circumstances); and it should be open, light, and clear, free from dust or dark, unburning coals; and a proper quantity of large clinkers should be placed on his fire-bars, to admit air freely. The fire-bars should never be allowed to burn any, for the

fire should at no time whatever touch them,—for large, well-burnt clinkers should be kept always on the top of them. This keeps the bottom of the fire hollow and open, and atmospheric air can then, with great facility, pass through them into the furnace. The bars themselves, at the beginning of smelting, are put in quite close together; and as the process goes on, and a good heat obtained, these bars are, one after the other, taken out more or less in number, as occasion seems to require. This removal of the fire-bars is for the freer admission of air, and gives room also for the furnace man to *hollow* up his fire, and keep it from choking. Now, a sticky, caking, Newcastle coal possesses all the evils that should be avoided in smelting works. The period of time, too, that the goods are in the furnaces, for this depends on the quality of the coal, is of the very first moment. When ready, not a moment should be lost; but the furnace at once tapped, and the metal and slag allowed to flow out. For with all care, lead, and so also silver, at a temperature lower than is generally supposed, will go off in vapor like steam from water. The quicker, therefore, the process, the better. The foregoing requisites—viz: carbon for the high temperature, inflammable gas (hydrogen), and which, perhaps, helps to reduce any oxide formed in the process,—and, above all, as positively one of the elements which are actually necessary, atmospheric air (or oxygen gas), to unite with the sulphur, and assist combustion—are all to be sought for in the furnace of the smelter. When longer than the usual time is required for flowing out your charge, in all probability the coals have been bad, and have not been *of the proper quality;* for will any coal furnish you with oxygen gas in quantity? In such delays, and from such causes, want of oxygen gas particularly, *the loss is often very great*, particularly in the continual volatilization of the metals—in the imperfect disulphurization of the ore—in the metals (even if separated) being suspended, like figs in a pudding, in the thick half-heated slag—and probably in much of the ore not metallized at all being mixed with, or suspended in, the imperfectly flowing slag. These evils arise from want of a higher temperature, and from a want of due admission of oxygen gas, which the bad coals would not allow to enter the furnace. *Bad* coal (that is, *bad* for smelting purposes) will keep the goods just in a midway state, between hot and cold—as it were, neither in the clouds nor on the earth —for a very considerable time. Such coals will, perhaps, run your ore into the state before mentioned, of a kind of black slag, by the sulphur not being discharged; and when once in this state the difficulty and expense in *extra* firing, *extra* fluxes, and *extra* heavy labor, &c. &c., are very considerable indeed, and the wear and tear of your furnaces much increased. The heat may have been great,—but the caking coals from their nature *not keeping apart*, with all the care of the furnace man, will not admit the very essential element—viz: atmospheric air—to freely pass onwards, and act on the ore. After the whole day's labor, and the time comes for flowing, on examining the produce you find the time and expenses have been all lost, and the *whole mass must go back into the furnace again for another term*, demanding greater care and expense than the first ill-fated attempt.

Now, although this kind of midway temperature will not flow your ores, with all your fluxes, yet it will do this very severe mischief—it will, notwithstanding its kind of neutral action, yet send perhaps half your metal into the air, never to be recovered again, and poisoning the whole of your neighborhood. Indeed, by continuing the use of such, you may volatilize nearly the whole of your metal away, to your very serious loss. Therefore, you see, it is no idle ignorance that demands a peculiar coal; but experience has taught the observant smelter that the best smelting coals are in the end the cheapest—indeed, more than one-third cheaper than any Newcastle coal at the usual price.

Now, as to the nature of the most desirable coal for smelting; it appears that anthracite or stone coal is nearly pure carbon, and free almost from hydrogen and bituminous matters—it is like in nature to wood charcoal. Now, it is evident that this coal would not do for smelting purposes—it affords no hydrogen, and no flame (or flare, as it may be called), which is required, both for heating the ore at a distance from the fire-chamber, and also for acting as a reducing agent besides,—carbon combined with hydrogen (carburetted hydrogen) not being afforded from it (stone coal) in sufficient quantity for the purpose of smelting. This coal is not a *caking coal*, and so far meets one of the requisites of a smelting coal. The Newcastle coal or bituminous coal, has all the necessary qualities as to *carburetted hydrogen* and *free burning*, that the other (the stone coal) is defective in; but it has the very great evil quality, of itself (as it were) *melting*. It becomes *soft*, and runs into masses, uniting itself together and capping, as it were, the top of the fire with an impenetrable cover. It continues very little time also in a solid form as coke and stone coal will do, but speedily burns away into a powder or ash; whereas the latter coal, the stone coal, will keep its form and figure, and therefore keep a hollow fire very much longer, and admit free passage to the atmospheric air through it, while the other coal will damp up the fire very quickly. A given quantity of stone coal will keep up, having once obtained a red heat, a greater heat for a much longer period of time than will a like quantity of bituminous or Newcastle coal. Neither the first nor the second quality, therefore, meets the wants of the silver-lead smelter. The first gives no flame, but will keep itself hollow—the second gives flame, but cakes into a mass. Neither will a mixture of the two answer the smelter's wants—no mixing together will answer the purposes required. You cannot form thereby a chemical combination—it can only be a mechanical one; and when a mixture of the two is thrown upon the top of a fire, the most bituminous part thereof will burn first, and the anthracite last. The same as if you well mixed together, in small shreds, some linen and worsted, and threw them upon a fire—your linen will be consumed before your worsted; and so with the above coals. At length you would have an anthracite collection only in your fire-chamber, if you used such a mixture; and, therefore, you do not obtain a desirable smelting fire. Now, if you could form a real chemical combination between these two coals, you probably would have a good smelting coal.

The art of man, I believe, has not effected this; however, *Nature*, it appears, has furnished such a combination. At any rate, she has produced a coal with all the requisites before mentioned, as being desirable in a good smelting coal. It is said that, in a coal basin or field, there is a gradual flowing, as it were, or chemical commixture, of one kind of coal into another—that, at one part of the coal basin, the highly bituminous quality shall be found, and at another part of the basin the pure anthracite coal shall make its appearance—in fact, that a very gradual change of quality is found as the two extremes slowly, as it were, approximate each other. If this be so, a good smelting coal could probably be found about that part of the basin which, is equi-distant between the richly bituminous coal, and the stone-like anthracite: probably, the best would be found nearer to the anthracite than to the bituminous formation.

It has been said—"If you burn *twice* or *thrice* as many bituminous or Newcastle coals in smelting, it must be cheaper than buying coals (of the quality above described) from Wales." No greater error on the nature of the coal required, can exist; and for reasons, indeed, above but partially explained. The following may with propriety be added, from a recent report of Mr. Mangham:—"It may not be irrelevant to state, that the averages of ashes, charcoal, and volatile matter, of the several samples of the best coking Newcastle and Welsh coal are as follows:—

	Newcastle.	Welsh.
Carbon,	0·760	0·777
Ashes,	0·054	0·027
Volatile Matter.	0·186	0·196
	1·000	1·000

—"Heating power of Newcastle coal is 309, and heating power of Welsh is 312. Hence we see that the Welsh coal is superior to the Newcastle coal both for coke and gas."—J. M———s. *August* 11. Min. Jour.

Suppression of the Smoke of Furnaces.

A report has been recently addressed to the Government, by Sir Henry De la Beche and Dr. Lyon Playfair, respecting the means and effects of preventing the smoke of furnaces. The following extracts will sufficiently explain the conclusions arrived at.

"The general principles upon which the combustion, or rather the prevention of smoke, may be effected are now well known, and admitted to be applicable in practice. Smoke consists of vapors produced by the partial combustion or distillation of coal, carrying up small particles of the fuel in mechanical suspension, and depositing, by the combustion of one of their constituents, carbonaceous matter in a fine state of division. The mode of preventing this smoke is to admit a sufficient quantity of air to effect the combustion of the carbonaceous matter, when the vapors are of a sufficiently elevated temperature to unite entirely with the oxygen of the air. If the tempera-

ture be not sufficiently elevated, the hydrogen of the vapors alone is consumed, and the carbon is separated in the fine state of division referred to. The gases produced by the complete combustion of fuel are colorless and invisible, and therefore do not come under the definition of the term smoke.

"As the prevention of smoke implies the complete combustion of fuel, the result, as an abstract statement, always is, that more heat is generated, and a saving of fuel effected, when it is so consumed as to prevent the emission of smoke; but although this theoretical conclusion is undoubtedly correct, the practical results are not always consonant with this statement.

"In consuming smoke in the usual way a quantity of cold air is introduced into the fire, and as this must be heated up to the temperature of the surrounding fuel, the loss of the latter may be equal to, or even greater than, the saving of the fuel from the combustion of the products of distillation. This often results in the careless use of furnaces constructed on the principle of smoke prevention, and thus leads to the contradictory statements given by those who have used such furnaces. But in all carefully conducted experiments the saving of fuel has been considerable, and the reason of this will be at once perceived, when it is considered that in addition to the combustion of the products of distillation there is a large amount of fuel saved by the combustion of a gas called carbonic oxide, formed by the proper product of combustion, carbonic acid, taking up, in its passage through the incandescent fuel, another portion of carbon, which escapes useless as regards the production of heat, unless burned by the air introduced at the bridge of the furnace, for the purpose of consuming the products of distillation.

"From these considerations, and from experiments conducted under our inspection, with a view to determine this point to our satisfaction, we arrive at the conclusion, that although from careless management of fires, there is often no saving, and that indeed there is frequently a loss of heat in the prevention of smoke, still that with careful management the prevention of smoke is in many cases attended with, and may in most cases be made to produce, an economy of fuel.

"It may be unnecessary to remind your lordship that the cause of the emission of smoke in manufactories may be classed under three different heads, the relative importance of which involves very different considerations in any attempt to legislate for its prevention. These are—1. The want of proper construction and adjustment between the fire-places and the boilers, and the disproportionate size of the latter to the amount of work which they are expected to perform;—2. The deficiency of draught, and improper construction of the flues leading to a chimney of inadequate height or capacity;—3. The carelessness of stoking and management by those entrusted with the charge of the fire-places and boilers."

It cannot for a moment be questioned, that the continued emission of smoke is an unnecessary consequence of the combustion of fuel, and that, as an abstract statement, it can be dispensed with. But your lordship will perceive that there are grave difficulties connected

with a general law to the effect that it shall be unlawful for chimnies, after a certain date, to emit smoke. With regard to steam-engines, the processes for the prevention of smoke have been matured, and in very many instances successfully employed. In this case, therefore, a law to that effect could be most easily and promptly carried out. In other cases mentioned in Lord Lincoln's letter, such as distilleries, dye-works, &c., the legislature has already granted powers in the Manchester Local Act; and as there are certain instances in which processes for the prevention of smoke have with them proved successful, it may be anticipated that the nuisance arising from these sources may be much abated, if they be subjected to the general law with that forbearance and caution which, under certain cases is so advisable. There are certain processes in glass-works, iron-furnaces, and potteries, in which it is neither possible nor desirable to apply a general law for the prevention of smoke; although the nuisance may be partially mitigated, by causing the steam engines employed in them to be so constructed as not to emit smoke. It is useless to expect, in the present state of our knowledge, that any law can be practically applied to the fire-places of common houses, which, in a large town like London, contribute very materially to the pollution of the atmosphere; but it may confidently be expected, that by a wise administration of a legislative enactment, carefully framed, a great progressive diminution of the smoke of large manufacturing towns will be effected, and that the most happy results will thus flow from this improvement, in the increased health and moral feeling of their population, the intimate connexion of which with facilities for cleanliness has been so often pointed out.

Civ. Eng. and Arch. Jour.

Paris Royal School of Mining.

The *Moniteur* publishes the usual ordinance, comprising the regulations of admission to the Royal School of Mining in Paris. It does not state that candidates for admission must be French, though they must speak the French language; and therefore there is no doubt that foreigners would be readily admitted, if found properly qualified. In the school the very best education that can be given is afforded to those who propose to devote themselves to mining pursuits, and to this education is united the advantage of practical instruction. The school is directed by mining engineers of the highest eminence, and by scientific men of the greatest learning. As there is no such institution in England, young men preparing themselves for the superintendence of mines, would do well, if possible, to avail themselves of the advantages of this school; and fathers of families destining their children for the mining career, could not possibly do better than send them to Paris.

At the recent examinations at this institution, Mr. J. Arthur Phillips, of Cornwall, stood first in mineralogy, metallurgy, and theoretical and practical chemistry.

Min. Jour.